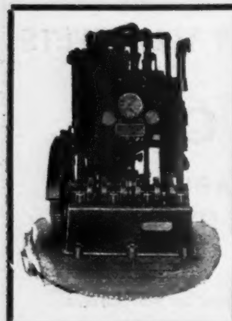
# Compressed Air

A MONTHLY MAGAZINE DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. IX. NEW YORK, OCTOBER, 1904. No. 8.



# "Compressed Air,"

OR

**THE COMPRESSED AIR MAGAZINE.**

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

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Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114 Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

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VOL. IX. OCTOBER, 1904. NO. 8


## After-Cooling and Reheating.

Important progress in the use of compressed air is being made in two ways—the cooling of the air immediately after compression and the reheating of it just previous to its use. There is nothing new about aftercooling or reheating; both have been discussed at length in COMPRESSED AIR. An examination of the most recent installation of importance in which compressed air figures will show, however, a tendency to make use of the advantages of both.

We are frequently receiving letters from users of compressed air machinery in which the complaint is made that the moisture in the air freezes as the air is allowed to expand. How is it possible to remove moisture from the air? What is the best method for lowering the humidity of the air under compression? These are but a few of the questions which come to us and all of which have the same bearing. The subject has already been explained in full in this publication, and some valuable hints will be found in the articles on the subject in previous numbers. A careful study of the conditions at the North Amherst Quarry of the Cleveland Stone Company, as described in the July number of COMPRESSED AIR, will enlighten the reader as to the methods which have been successfully used in this installation. It is significant to note that while that plant has been operated when the mercury had fallen to a very low point, there never has been any trouble from freezing in the pipe lines or machines where the compressed air was used. It may be remembered that a similar experience was met with in building the Jerome Park Reservoir, where the compressor plant was kept in constant operation through a cold winter. In that case aftercooling was so successful that never did the rock drills have to lose a moment on account of freezing in the valves.

These practically illustrate the truth of the theories advanced heretofore and prove that they can be used with such results as to warrant their general adoption.

Reheating has not been used so generally. While it is a prevention against freezing, its chief value is an aid to great economy. Its success in this particular was noted in the description of the Cleveland Stone Company. The cost of the necessary fuel for reheater is very small and the increased efficiency of the machine using compressed air at a high temperature more than pays for it in the vast majority of cases. There are instances where the saving effected by reheating is not of sufficient importance to make it worthy of consideration. The trend of modern practice is advocating the adoption of every means possible to secure economies, and, as this influence grows, the reheater will continue to occupy a more and more important place in the compressed air plant.

## Discussions.

An interesting communication by J. D. G. is published in this issue of COMPRESSED AIR. He has read with interest the paper by Mr. Lucius I. Wightman on " The Electrically-Driven Air Compressors for Metal Mining," and he gives additional facts of interest.

The columns of COMPRESSED AIR are open at all times to those who care to discuss the articles which appear in this publication. It is our purpose to reflect as far as possible the general thought on the subject of air compression and its application. Such a subject naturally brings forth many ideas, some important, some impossible, but all of interest. We give publicity to these ideas and leave the authors to defend their own positions. We may feel called upon, occasionally, either to explain some point under discussion or perhaps comment on the suggestions and theories which may be advanced.

Any communication from a reader of COMPRESSED AIR will be given careful consideration and published if of general interest.

## Advertising Suggestions.

Much interest has been shown in the advertising competition which COMPRESSED AIR is conducting for the Ingersoll-Sergeant Drill Company. A number of suggestions have already been received while there have been been many inquiries as to the terms of the contest. For the benefit of those who did not see the terms as they appeared in the September issue of COMPRESSED AIR, we will outline them briefly here:

Five prizes will be awarded for the advertisement best suited to the requirements of that company. They will be as follows:

| | |
|---|---|
| First prize................. | $25 00 |
| Second prize............... | 10 00 |
| Third, fourth & fifth prizes.. | 5 00 each |

A prize of $10 for the best and most original suggestions for keeping the name of the Ingersoll-Sergeant Drill Company before the public.

Each advertisement should be prepared for one of the following trade papers, designed to fill the same space as the company's regular advertisement in that paper: *American Machinist*, COMPRESSED AIR, *Engineering Magazine, Engineering News, Engineering and Mining Journal, Granite, Mining and Scientific Press, Mines and Minerals, Railroad Gazette, Railway Age* and *Rock Products.*

Selections will be made from the advertisements received and they will be published. The final choice will be made from among the advertisements which have appeared in print. The Ingersoll-Sergeant Drill Company reserves the right to copyright and use any of the advertisements submitted.

The competition will close November 1st and the awards will be made as soon after that time as possible.

All suggestions should be sent to COMPRESSED AIR, 26 Cortlandt Street, New York.

## The Hudson River Tunnel.*

### A COMPARISON OF THE ORIGINAL METHODS WITH THOSE NOW EMPLOYED.

The late De Witt C. Haskin certainly demonstrated the strength of his convictions when he began operations upon the tunnels under the Hudson river connecting New York and Jersey City, and which are now rapidly nearing completion. His plans were scoffed at and ridiculed by engineers whose opinions influenced capital. They

* By S. D. V. Burr in the *Iron Age*. We are indebted to the *Iron Age* for the accompanying illustrations.

pronounced the scheme impracticable and extremely hazardous, and for several years would have nothing to do with the undertaking. It was only after Mr. Haskin had conclusively proved that he could build a subaqueous tunnel through soft material, without a shield and without any protection whatever except that afforded by the mud itself, that engineers began to be less skeptical and to acknowledge that there might, perhaps, be something in the idea. from plates or sheathing. That the method was feasible is to-day demonstrated by several hundred feet of tunnel that were constructed in accordance with it.

This work was done by Mr. Haskin with his own money and before he endeavored to obtain outside capital. He proved the soundness of his judgment, and when his own money—several hundred thousand dollars—had been expended he brought in other capital.

FIG. I.—VIEW LOOKING TOWARD HEADING, SHOWING CENTERING AND RADIAL BRACING OF PLATES.—THE TRACK IN THE CENTRE IS PLACED DIRECTLY UPON THE "PILOT."

He showed that it was possible to maintain such a balance between the air pressure within the tunnel and the water pressure without that a very slight barrier or partition would serve to keep the two apart. This barrier was formed by the mud itself, with absolutely no assistance

### Tunneling with an Unprotected Heading.

The most remarkable feature of this plan was its extreme simplicity. The heading was divided into steps, or terraced, and upon these steps the men stood

while shoveling out the silt, which was thrown back into the completed section. After sufficient space had been excavated a plate was inserted and bolted to the ones already in place. This work was commenced at the crown and carried down each side to the invert. The plates down the sides conformed to the shape of the heading, so that the iron work resembled an exaggerated buggy top. When four

The plates were of ¼-inch boiler iron, and all were 2½ wide, but some were 3 feet long and others 6 feet. A 3-inch angle iron flange, pierced with holes every 6 inches, was formed around each plate. As the plates were put in they were braced from the bottom by timbers resting upon sleepers inserted in the silt. After the men had become accustomed to the work it was found possible to build an average

FIG. 2.—LOOKING DOWN THE SHAFT AT THE WEST END.—THE AIR LOCK IN WHICH 20 MEN WERE KILLED IS SHOWN SUSPENDED AT THE LEFT.—IT WAS ORIGINALLY PLACED IN THE WALL JUST ABOVE THE THREE MEN.

complete rings, or 10 feet, had been finished, the section was cleaned out and the masonry laid. This was of hard burned brick in hydraulic cement, and at first was 2 feet thick; this was afterward increased to 30 inches where the tunnel approached the deepest part.

of 5 feet a day. This was better than the progress made when the shield was first used.

It is now expedient to mention some of the first work done, much of which was of a temporary character and was not made permanent until about 300 feet of tunnel had been finished.

### First Work.

The first work, after borings had been made across the river in line of the tunnel, was the sinking of a circular brick shaft, 30 feet inside diameter by 4 feet thick, to a depth of 60 feet below the river surface. At a point on the river side 29 feet below the surface an opening was made to receive an air lock 15 feet long by 6 feet in diameter. It now became necessary to carry the excavation from the inner end of the lock down to the 60-foot level. A very small space was dug at the top of the inner or forward end of the lock, and a flanged iron plate put in position; side plates were added until a ring had been finished. Successive rings were added, but each ring was made larger than its predecessor, so that the whole resembled a funnel having a straight top and a bottom formed of steps. The top and bottom of the last or largest ring were in line with the top and bottom of the tunnel. At this time it was proposed to build one single track tunnel, 24 feet high by 26 feet wide, but this was afterward changed, and two tunnels were started, 18 by 16 feet in diameter.

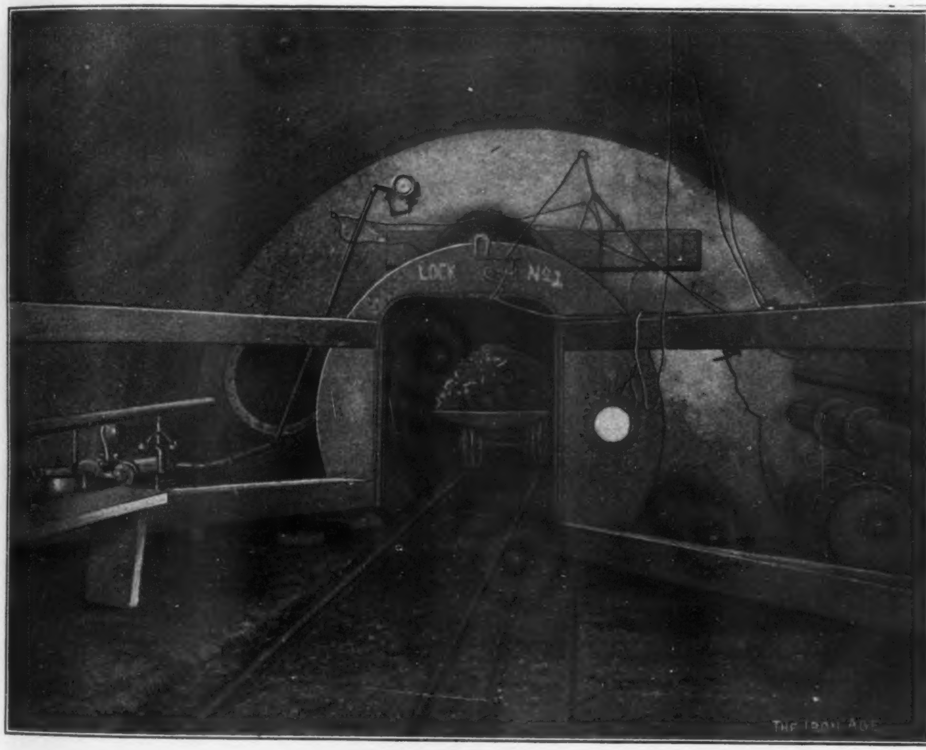



FIG. 3.—LOCK NO. 1.—THE TIMBER LOCK IS SHOWN AT THE LEFT.

After both tubes had been dug for some distance it was decided to remove the temporary entrance and make permanent connection with the shaft. The work was progressing with apparent safety when a blow-out occurred in 1880. The leak was at the junction of the entrance and shaft, and took place during a shift. Eight men had entered the lock and twenty were on the way. The falling debris blocked the

inner door so that it could be neither opened nor closed, and yet the space was not sufficient to permit entrance to the lock. When it was certain the door could not be moved the bullseye in the front end was smashed. The pressure inside was soon reduced to normal, when the first door was opened and the eight men in the lock escaped, but their comrades were all drowned.

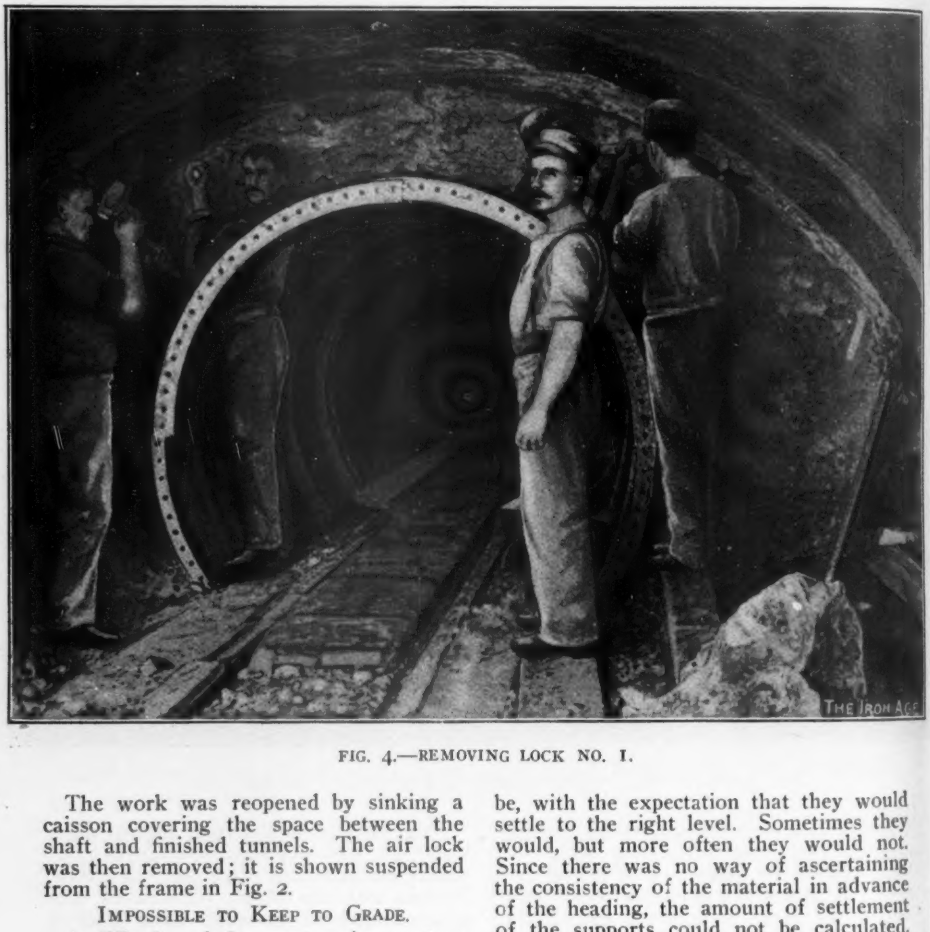



FIG. 4.—REMOVING LOCK NO. I.

The work was reopened by sinking a caisson covering the space between the shaft and finished tunnels. The air lock was then removed; it is shown suspended from the frame in Fig. 2.

IMPOSSIBLE TO KEEP TO GRADE.

A difficulty of the most serious nature was met during the early stages of the work. It was found to be impossible to maintain the proper grade. The silt varied in compactness, and therefore the supports for the plates did not always provide the same resistance. This caused unequal settling before the masonry could be placed. The consequence was that for the first 300 or 400 feet of the north tunnel the line assumed its own elevations, irrespective of the desires of the engineers.

An attempt was made to overcome this by placing plates higher than they should be, with the expectation that they would settle to the right level. Sometimes they would, but more often they would not. Since there was no way of ascertaining the consistency of the material in advance of the heading, the amount of settlement of the supports could not be calculated. This led to the introduction of the

"PILOT,"

by John F. Anderson, then superintendent of the tunnel. This consisted of a tube

of $\frac{1}{4}$-inch boiler iron, made up of interchangeable plates 22 inches wide by 4 feet long, having angle irons around the edges. This was 6 feet in diameter and 50 to 60 feet in length. The forward end was extended beyond the heading some distance into the silt, by which it was firmly held. The tube projected through the unfinished section into the completed work, where it was supported by radial struts against the masonry. By this means a rigid foundation was obtained, from which the plates could be held with certainty during the laying of the brick work. An additional advantage was that the direction could be changed at will. The operation of the pilot will be understood from the sections, Fig. 7, and the appearance of the heading from the half-tones, Figs. 1 and 5. The pilot was used for the building of several hundred feet of tunnel, or until the English engineers, Messrs. Fowler and Baker, assumed charge, when the shield method was employed. This method has been continued by the present engineers.

Without the pilot the tunnel would never have been built as far as it was—in accordance with the original plans—and work would, of necessity, have been abandoned. The first few hundred feet of the north tunnel indicated what was to be expected as the work progressed. It would be useless to continue a tunnel which was bound to assume its own grades, irrespective of what the engineer thought proper. It was, of course, known that these faults could be corrected after completion, and that, while the job would be expensive, it would present no serious difficulty from an engineering standpoint, since all the work would be at the invert of the tunnel.

The unprotected heading did not enter the problem. The work had been, and was still to be, carried on successfully by this plan, which if expedient at small depths would be equally so at greater depths provided the material passed through remained the same. In fact, the unprotected heading was still used when the air reached a pressure of 36 to 38 pounds to the square inch. The photograph Fig. 1 was taken under the latter pressure.

### Watching for Air Leaks.

Before the adoption of the shield it was necessary to continuously and carefully watch the entire exposed surface of silt for leaks. A large opening could be detected by the noise made by the outrushing air and a small one by passing a candle over the surface, when the air would draw the flame into the most minute hole. A handful of silt acted as a stopper.

Pockets of loose material, like sand, were sometimes met in the line of the tunnel. When small these occasioned little difficulty, but when large they were more than once the cause of flooding the tunnel. In one such break the silt and sand completely filled the heading and formed a considerable depression in the bed of the river. This depression was filled with bundles of hay weighted with stone and then covered with earth, the whole then being allowed to settle for a few days. The heading was then pushed through the obstruction in the usual way, the men for a long time digging out sand, silt, rock and fodder.

In the case of a pocket the action of the air was intermittent. At first the air flowed out until the pressure of the water became excessive, when the water flowed in. Then the pressure of the water became the greater and it escaped, this alternating movement continuing until the tunnel had been filled. It will be readily understood that those movements consumed considerable time, which was most fortunate for the men, as it gave them an opportunity of reaching the lock in advance of the water and thus escape. In no case was a man killed by reason of a blowout at the heading.

### Silt.

In its physical characteristics silt resembles both clay and quicksand, paradoxical as this may appear. When it carries just the right amount of water it is stiff, compact and tenacious to a certain degree. With an excess of water it runs like quicksand and is just about as hard to control. It is very evident that with a material of this kind constituting the heading of a subaqueous tunnel it became of the greatest importance to maintain, as accurately as possible, a true equilibrium between the hydrostatic head without the tunnel and the air pressure within. But this could not be done over the entire area of the heading, for the reason that while the air pressure was the same at all points, the water pressure varied according to the depth. As the excavation was about 23 feet from the crown to the invert, there was a difference of about 10 pounds between the pressure of the water at the top and bottom. Since it

was impossible to balance the inside and outside pressures at all points of the exposed surface, it was necessary to assume an air pressure somewhere between the water pressure at the top and bottom of the excavation. This, which may be termed the critical point, was found to be about one-third from the top to the bottom. Above this the air pressure was in excess and gradually forced the water out of the silt, leaving the latter in a more or less dry condition and with a tendency to flake off. Below this the water pressure was the greater, and the silt, being too wet, was apt to run. The latter aspect was not thought to be dangerous, and therefore only the upper portion was watched carefully and constantly, as stated above.

The foregoing merely gives the main points of the methods introduced under the direction of Mr. Haskin. The experiment—for such it really was—was successful. At this date the plan is interesting only as an experiment, and not because it marked a radical and important advance in tunnel construction. It is safe to predict that it will never be tried again.

Engineers upon their first visit to the heading all had the same feeling of insecurity. They knew they were at least 80 feet below the surface of the river; they knew there was solid masonry and a strong air lock in the line of their retreat; but, above all, their eyes convinced them that there was nothing but a wall of mud between them and the Atlantic. They were aware that this mud would run like

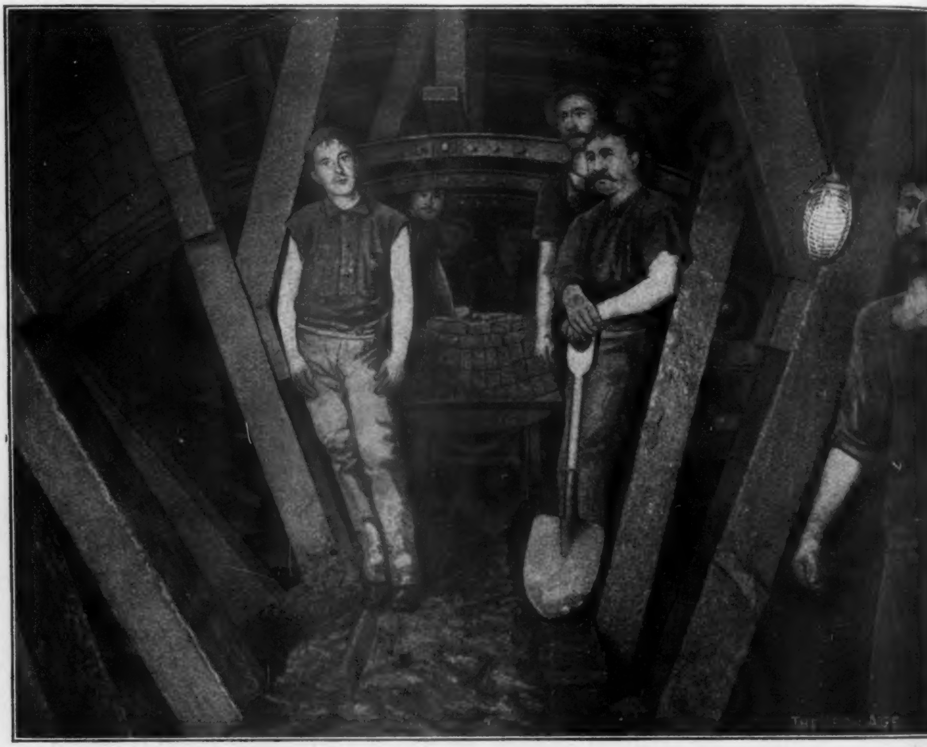


FIG. 5.—VIEW LOOKING FROM THE HEADING, SHOWING BRACING, CENTERING AND TOP OF PILOT.

quicksand if it carried the proper amount of moisture, and the knowledge that it was a comparatively stable material under correct conditions did not relieve their anxiety. The first visit was always like a call of ceremony—as brief as it could conveniently be made.

### Working Through Sand and Gravel at the New York End.

The nature of the material at the eastern, or New York, end was radically different from that encountered upon the New Jersey side. When at the required depth the caisson rested entirely in sand and gravel, which presented no barrier to the passage of air, and consequently prohibited the adoption of the method employed in the silt. After the two tunnels had been started from the side of the caisson work was commenced at the crown of the bulkhead at the heading. This bulkhead was of ¼-inch plates, flanged, and braced against the caisson. The crown plate was removed, and enough material was excavated to admit a small plate, which was bolted to those already in. This work was carried forward and down each side as far as possible before the next row of horizontal plates in the bulkhead was removed. When the crown had been extended 10 feet a second bulkhead of plates was begun. The removal of the plates from the first bulkhead was so timed that the upper edge of this bulkhead was always kept at a higher elevation than the lower edge of the advance bulkhead. The chamber thus formed was exactly like the compartments of the ordinary shield and served precisely the same

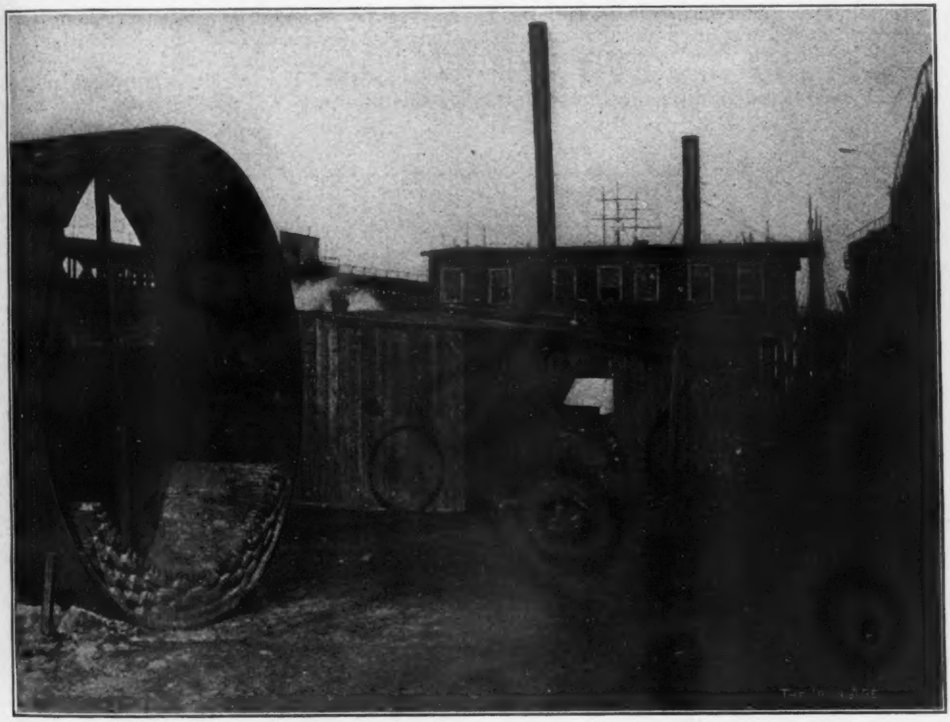


FIG. 6.—VIEW OF BUILDINGS.—THE RING AT THE LEFT OF THE CUT IS AN EXACT REPRODUCTION OF A SECTION OF THE TUNNEL.

purpose. As long as the air pressure was maintained it was impossible for water to enter the tunnel, owing to the difference in level of the horizontal edges of the two bulkheads.

As soon as a section of 10 feet had been entirely lined with iron plates it was cleaned out and the brickwork laid.

As already mentioned, the sand and gravel offered no impediment to the escape of air. To overcome this difficulty cement was forced into the sand at the spot where it was intended to excavate for a plate. Afterward, silt brought from the other side was used for this purpose, and it filled all requirements admirably. Wet silt spread over a patch of exposed sand made it practically impervious to air. his back. Although the heading was small and had many incandescent bulbs, candles were freely used in order that the men might see work in hand.

An exposure of 40 minutes with 20 incandescent lamps hidden behind the nearest braces gave no image whatever. A calcium light outfit could not be made to work under the pressure—34 to 38 pounds to the square inch—and after the connecting tubes from the burner to the cylinders had burst two or three times, the men became frightened, and that plan had to be abandoned. Four-arc lamps were provided, each with a reflector behind it so that the light could be directed where needed. Fair results were obtained by this means.

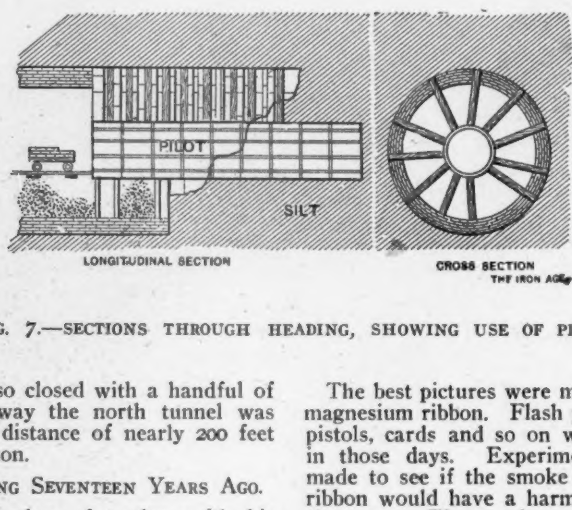



FIG. 7.—SECTIONS THROUGH HEADING, SHOWING USE OF PILOT.

Leaks were also closed with a handful of silt. In this way the north tunnel was finished for a distance of nearly 200 feet from the caisson.

### PHOTOGRAPHING SEVENTEEN YEARS AGO.

The photographer of to-day, with his wonderful facilities for producing a powerful light having the highest actinic quality, and with his rapid lens and quick plates, cannot estimate the troubles of "the crank" in 1887. In that year the writer made many attempts before even an image of any kind was obtained. The surroundings were disadvantageous. The wet silt, which covered everything in sight, was of a peculiar dark slate color, which appeared to absorb the light as effectually as a dead black would have done. The writer has seen a man groping in his own shadow for something he had dropped, and with an electric light almost touching

The best pictures were made by burning magnesium ribbon. Flash powders, lamps, pistols, cards and so on were not known in those days. Experiments were first made to see if the smoke of the burning ribbon would have a harmful effect upon the men. The results were most satisfactory. The ribbon was fed from a reel through an opening in the centre of a reflector. With this apparatus the views in the heading, Figs. 1 and 5, were taken, the exposure in the first case being about ten minutes and in the second about four minutes. The views Figs. 3 and 4 were made by burning magnesium ribbon in pieces about 2 feet long, hung on a wire stretched across the tunnel just behind the camera. The ribbons were lighted by a candle, one after the other. The fogged appearance of the first engraving was caused by the dense smoke of the burning

ribbon, which, in that closed chamber, dissipated very slowly.

The views are certainly not works of art, but under the conditions then prevailing were considered passable. The pictures then taken form the only photographic record of the early work.

The New York & New Jersey Railroad Company, with W. G. McAdoo as president and Charles M. Jacobs as chief engineer, acquired the franchise and property of the original Hudson Tunnel Railroad Company in the early part of 1902. Since then the work has been carried forward without undue trouble, the north tunnel has been opened from shore to shore and operations have been begun on the approaches.

The most important change made by the English engineers, after the introduction of the shield, was the substitution of heavy cast-iron plates for the masonry. The light boiler plates used in the early work were never considered as being an integral and permanent part of the cylinder; they only served to keep the silt out until the masonry had been laid, after which their existence was of no moment.


FIG. 8.—NORTH TUNNEL, SHOWING COMMENCEMENT OF NEW WORK, APRIL, 1903.

The plates in the south tunnel, which has been reduced in inside diameter to 15 feet 3 inches, are 6½ feet long, 2 feet wide, 1 7-16 inches thick, 8 inches deep through the webs, and the flanges are 1½ inches thick. All the bolt holes are 1½ inches. The sides of each plate are accurately faced, the long ones being in a plane at

right angles with the axis of the tunnel and the short ones on a radius, so that they fit together with the greatest nicety. An inspection of Fig. 8, which shows the first work done under the present management, will convey a comprehensive idea of the regularity and precision of the work. With these plates it is impossible to distort the circular section of the tunnel, and with the shield it is easy to follow the exact grade and alignment.

management assumed control was at the lowest point, with but a few feet of silt overhead. With these surroundings it was not thought expedient to reduce the diameter of the shield.

### The Shield

consists of a steel cylinder somewhat larger than the outside diameter of the tunnel, and provided with a central and a forward vertical partition. Between the


FIG. 9.—ERECTOR OF PLATES.—NORTH TUNNEL, LOOKING WEST TOWARD ERECTOR, IRON JOINING OLD BRICK WORK, APRIL 19, 1904.

The change in diameter was brought about by the alteration of the use to which the tunnel is to be put. While at first intended for regular steam traffic, it will now be employed only for trolley and light service. The same plan would have been adopted with the north tunnel but for the fact that the heading when the present

partitions are small chambers in which the men stand while digging the silt through openings in the front and throwing it through openings in the rear. The advance end of the cylinder is in the form of a cutting shoe, which enters the silt as the shield is forced forward by hydraulic rams resting against the completed part of

the tunnel. The shield covers the entire heading and overlaps a part of the permanent work. It resembles a cap in that it covers and protects the whole heading, and is the direct opposite of the first plan with the silt all exposed.

The shell of the shield is of ⅝-inch steel, 19 feet 5¼ inches outside diameter and 10½ feet long. Between the two partitions are nine working chambers, formed by two vertical and two horizontal walls, which are spaced 6 1-3 feet. In each chamber the upper edge of the forward opening is lower than the lower edge of the inner opening, so that so long as an air pressure is maintained equal to the hydrostatic head it is impossible for the water to enter the heading.

The plates, being much too heavy to be handled by manual labor, are placed in position and held until bolted to those already in place by an erector, shown in the centre of Fig. 9, which is operated by hydraulic power. The arm is mounted on a shaft so as to swing in a circle perpendicular to the axis of the tunnel. In operation the outer end of the arm grasps a plate, swings it to the required location and then forces it out to its seat, where it is held until the bolts have been inserted. The device is extremely simple, and works easily and rapidly.

This system of tunneling, in direct contrast with that first employed, provides absolute safety for the men. Moreover, a blowout, of more or less frequent occurrence during the early progress of the work, cannot happen, and the flooding of the heading could only take place through the complete disablement of the air compressing plant. With these advantages there is the additional one of greater rapidity in construction, with the accompaniment of less labor, and therefore reduced cost.

After leaving the river bed the two tunnels will converge into a double arch concrete steel tunnel, 17½ feet centre to centre, and each having a roof with a radius of 7½ feet. This tunnel opens into a three-track single tunnel, also built of concrete steel, which extends to the terminus at Christopher and Greenwich streets. The shore work will all be done in open cut.

The photograph, Fig. 8, for which and for Fig. 9 we are indebted to the courtesy of the chief engineer, Charles M. Jacobs, was taken at the meeting point of the shield and the masonry built twenty years ago from the New York caisson. It will be seen that the shield meets the brickwork almost exactly in line, after having come nearly a mile from the New Jersey shaft, and having been twenty-five years making the distance.

## Operation of Quarries.*

The question of operating quarries is one that includes probably as many difficulties as any other department in the manufacture of lime. The peculiar condition of quarries, by reason of geological formation, makes it difficult to lay down any rule or system that will generally apply to all quarries.

In Pennsylvania the limestone formation is mostly of a perpendicular nature or variations of the perpendicular, so as to make quarrying much more difficult than it is in States like Ohio and Indiana, where the measures are generally flat or in their natural beds. In Pennsylvania, especially the central and eastern portion, the rock generally comes to the surface and there is but little covering to be removed, while in western Pennsylvania and Ohio what observations I have made lead me to the conclusion that the removal of the top earth or covering presents an entirely different proposition when you come to quarry stone in that vicinity than is presented in central and eastern Pennsylvania, where the stripping does not materially interfere with the operation of the quarries.

The old-time method of hand-drilling when three sledgers and a drill turner would, at their best, probably drill twenty feet a day, and when the missing of a shot resulted in a stagnation for the time being of the output of the quarry, are practically things of the past. Quarries worked under the old method and old style are well termed "behind the times," and from a financial standpoint are not likely to be very profitable or very successful.

Steam drills succeeded the hand drilling, but it had its difficulties in the condensation of steam in cold weather, the burning of hose, the difficulty in getting water to the portable boilers generally used, as well as fuel in the same condition, the dangerous leakage of steam pipes when

***Abstract of a paper read by Mr. A. A. Stevens, Vice-President and General Manager of the American Lime and Stone Company of Tyrone, Pa., at the 1904 annual meeting of the Lime Association held at Pittsburg, Pa.**

suspended over ledges, were all difficulties that raised objections to steam drilling and called for something better.

Compressed air has practically driven steam drilling where steam drilling forced hand drilling, and at the present time no quarry of any extent can be successfully and economically worked without its compressed air plant.

The question of which is the best compressor is merely a matter of judgment. Within the past few years the manufacture of air compressors has been taken up by very many and large concerns, resulting in the putting on the market of very high class of compressors and a cheapening of the price of the same. From a dollar and a cent chapter of power, it is very doubtful whether compressed air is the cheapest power for drilling — whether steam was not cheaper, but when you consider the ease with which compressed air is transmitted, the distance that it can be carried without any particular loss of power, the safety from injury to operators, the economy in the use of hose as against the use of hose in steam drilling and the concentration of the generating of power at a point where fuel and water can be gathered, gives the quarry operating by compressed air a working advantage that has not been equaled by any other known method up to the present time.

With these improvements have also come improvements in drills, and while there are many drills manufactured by different concerns, after all the drill with the fewest parts, the easiest cared for, the repairs for which can be furnished at a reasonable price and be promptly obtained when desired, is the drill that the modern quarryman will adopt in his work.

Different opinions have existed as to the size of the drill best adapted to quarry purposes. My observation has been that the 3¼-inch drill, weighing approximately 250 pounds, with a working efficiency of twenty feet, is the best drill for general uses and purposes. A drill of this size in the average limestone quarry of Pennsylvania, in the hands of a competent driller, ought to make 75 feet per day under average conditions.

Whether the driller will do this or not depends very largely upon the geological formation of the rock through which he has to drill as well as to the hardness of the rock. I have seen good drillers who worked faithfully who would not make over twenty feet per day, while I have seen the same driller at another point in the same quarry make seventy-five feet per day, so that what a day's work in drilling is is not easily to be fixed.

While considering the question of drills, I may as well refer to the next advance or improvement that has and is doing away with the "Pop" drilling by which the quarryman with his hand hammer and drill broke down the rock to a sledging size by drilling holes from six to ten or more inches and which would require about five minutes of time for every inch of hole he could drill. Within the last year the manufacturers of air drills have introduced small drills, easily handled by one man, consuming but very little power and which can be depended on to drill one inch per minute and to a depth of from twelve to fifteen inches.

I have had some experience with these drills with satisfactory results. I have given no preference to several that are in the market, for the reason that my testing has not yet been sufficient to decide just which is the best.

Between this small, or Plug drill, as it is better known, and the tripod rock drill, is an intermediate drill which I think is made only by the Chicago Pneumatic Tool Company; this drill weighs from 75 to 80 pounds and will drill from two to three feet at the rate of more than one inch per minute.

While this drill is effective in the work that it does, there are a good many weaknesses connected with it. First, the wear and tear on the mechanism of the drill is hard and repairs are expensive; second, the drill is cumbersome for one man to handle. I have had one of these drills in use for some months and while it has been a great improvement over anything before it, yet I believe the manufacturers will improve it so that it will be greatly more efficient so far as economy in operation is concerned. It is also pretty hard on power, taking almost as much air to successfully run it as is used in an ordinary three-inch drill.

I think I am safe in saying that the progressive quarryman of to-day is looking forward with a great deal of anxiety for the application of electricity as a means of power in rock drilling. I have, during the past year examined and investigated all, with one exception, of the electric drills offered for sale, and so far

as my judgment goes, none of them are of any practical use in the average limestone quarry because of their unwieldiness and difficulty incident to their operating. Whenever these difficulties are overcome and power can be applied to them with as much ease as compressed air is applied to a drill, quarrymen will be ready to take off their hats in respectful acknowledgment of their greatest benefactor, but, for the present, it looks to me as though compressed air and plenty of it is to be the successful means of economical rock drilling.

There are many little details that enter into the economical management of quarries that are applicable only to each particular quarry as its conditions present themselves. The importance of keeping the quarry clean, tracks in good condition, cars in good repair and all other arrangements for handling and operating, are things that every quarry superintendent must develop for himself.

Every successful superintendent has some ideas, some advantages, some economics in operating that others do not have, and I have always been of the opinion that it is a good thing for quarry superintendents to get rid of any possible selfishness as to their own ideas and when the opportunity presents itself to visit other quarries, where there may be no objections, to confer with other superintendents, exchanging their own ideas and in that way widen out their own abilities and become helpful to each other without in any way interfering with the business of each other.

The days for exclusive ideas, of working in your own ruts and thinking no one else knows as much as you do, and, therefore, you don't want any one to know as much as you do, are practically things of the past. The progressive quarryman of to-day realizes that he does not begin to know it all, that he is willing to be taught as well as to teach, that he is willing to exchange ideas for ideas, plans for plans, and to meet his fellow quarrymen on the broad grounds of intellectual business reciprocity and by such means as these we will all be benefited, our methods will be improved, economics will be substituted for waste and our superintendents, by thus rubbing up against each other, will, like the diamond under the same conditions, become brighter and more valuable.

## An Air Valve for Regulating the Time of Passing Through an Air Lock; Used in the Kiel Dry-Dock Construction.

In describing the construction of the concrete dry-docks at Kiel, Germany, we mentioned that the air locks were fitted with valves designed to give gradual equalization of pressure between the two sides. The valves constituted automatic regulators operating thus: When locking-in, compressed air was admitted at such a rate as to give a uniform rate of pressure-increase (1.5 pounds per minute), while when locking-out, the escape of air was regulated so as to give a uniform rate of decrease of pressure (¾ pound per minute), only half as large as the rate of locking-in. The object of using these valves was to prevent the possibility of injury to workmen from too rapid transition to or from compressed air.

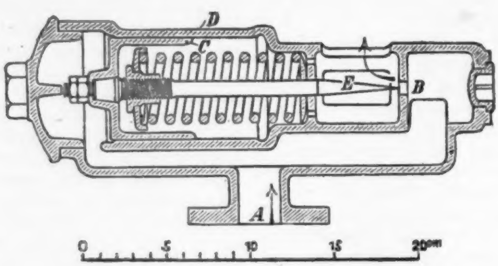
We show herewith a sectional drawing to illustrate the construction of the valves, in response to a request for further information concerning their nature and working. This should prove the more interesting because in the extended use which American engineers have made of the pneumatic method of construction, no attempt has been made to reduce the injurious effects of rapid locking by employing valves with a controlled time-element.

The valve shown has a small air passage *B*, regulated by the needle *E*. This needle is attached to a small piston *C*, acted on by the higher pressure on one side and by the lower pressure on the other. This latter pressure is aided by a coil spring, which tends to force the piston to the left, opening the needle aperture to its full extent. The actual position of the needle at any time, therefore, depends upon the difference of pressure of the air on the two sides of the piston.

One such valve is attached to each air lock for locking-in, and another for locking-out. In the former, the compressed air from the supply mains enters at *A*, and passes through aperture *B* to the discharge openings at *E*, leading into the air lock. The air from *A* also passes around behind the valve piston and presses the needle over to the right up to a point where it is balanced by the pressure from the air in the air lock. As the

pressure in the air lock gradually increases, the piston is forced over to the left, increasing the size of aperture *B*, since the effective head of air across *B* is now less, however, the rate of flow is not increased proportionately.

The valve for locking-out is connected to the air lock by the opening *A*, and to the external air by the openings at *E*. The operation is as described above. A separate smaller valve, however, admits fresh compressed air to the lock at half the rate of the escaping air, so that the effective rate of pressure-decrease is only ¾ pound per minute. It is well recognized, of course, that locking-out is more injurious than locking-in; a slower transition in locking-out was thought advisable for this reason. This might have been done by simply using a smaller valve, but the arrangement described was adopted engineer in charge of the Kiel dry-dock construction say: "In general they gave very good satisfaction. Occasionally, however, they failed in cold weather through ice forming in them because of the drop in temperature produced by the expansion of air at the needle aperture. Difficulty was sometimes encountered in beginning the process of locking, when the valve could not admit air rapidly enough to close the lock doors airtight. Ordinary air cocks, which were also fitted to each lock, were used in such cases to give a sudden pressure-increase sufficient to seal the doors, after which the time-valve completed the equalization." The ordinary cocks, it should be remarked, were arranged to be operated only by special keys in the possession of inspectors and lock-tenders.—*Engineering News.*




SECTION OF AIR VALVE FOR SLOW PRESSURE-EQUALIZATION IN AIR LOCKS.

BUILT BY KOERTING BROS. FOR USE IN THE DRY-DOCK CONSTRUCTION AT KIEL, GERMANY.

at Kiel in order to supply fresh air to the caisson during the relatively long period of locking.

With a caisson pressure of 30 pounds per square inch, or two atmospheres, the operation of locking-in with the use of the above-described valves would require twenty minutes, and locking-out would take forty minutes. These rates are of course exceedingly slow compared with American practice, but of course the principle can be worked out in a valve giving a more rapid equalization.

The valves were made by the firm of Körting Bros. Co., of Hanover, Germany. Regarding their operation the

## The Fisher Air Compressor.

Two air compressors, differing from other types in several particulars, have been placed on the market by A. J. Fisher, of Chicago. The older of the two is a steam-driven tandem compressor. It is particularly adapted where space is a consideration. It may be attached to almost any type of steam engine, from a hoisting engine to the largest size Corliss, which has surplus power to compress the quantity of air desired. Figure 1 shows this type of compressor.

With the internal explosion engine

coming largely into use, the Fisher gas or gasoline air compressor as shown in figure 2 has attracted attention. It is

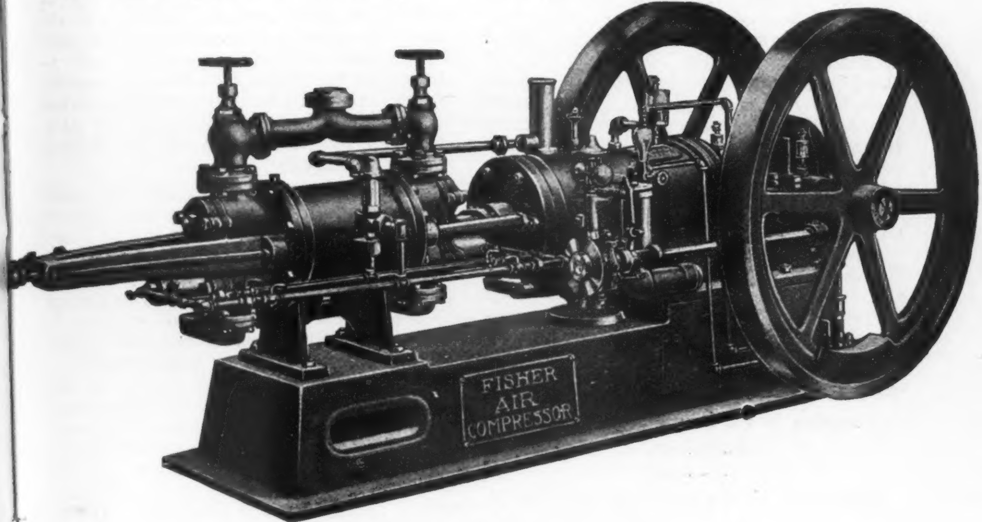



FIGURE 1.

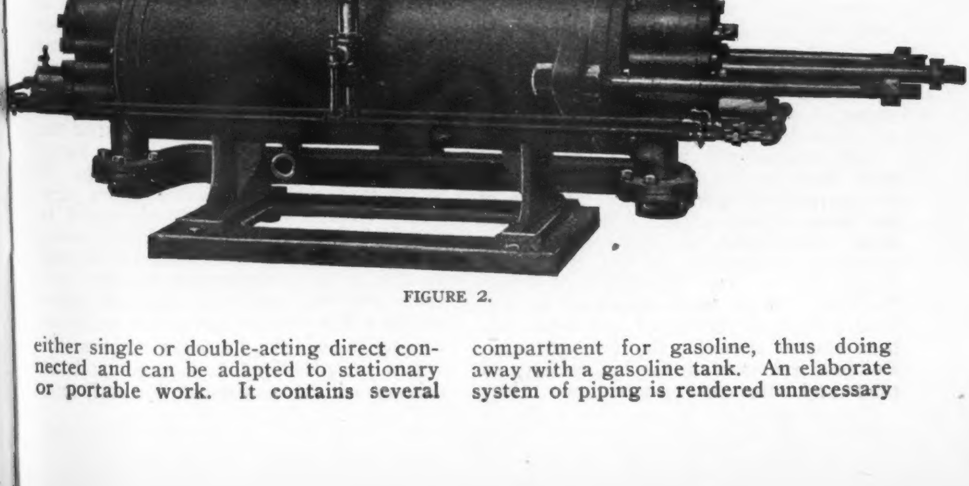


FIGURE 2.

either single or double-acting direct connected and can be adapted to stationary or portable work. It contains several important differences from other types. In machines up to and including 30 H. P. there is cast in the bed of the machines a compartment for gasoline, thus doing away with a gasoline tank. An elaborate system of piping is rendered unnecessary

as the water is circulated through a hollow piston rod, through the water jacket of the compressor and engine, returning to the barrels or other vessels from which it was taken. A hose connection attached to the end of the hollow piston is used as the water inlet pipe. If desired the water supply may be taken from a hydrant or pump. This feature enables the compressor to be used close to the work to be done as it is not dependent on any fixed water supply. They are built in sizes ranging from 8 up to 100 H. P. and with capacities from 35 to 500 cubic feet of free air per minute.

Christopher Murphy & Co., Marquette Building, Chicago, are the sales agents, and Thomas W. Pangborn, 42 Dey Street, New York, their Eastern representative.

## Work of the Electric Railway Test Commission of the Louisiana Purchase Exposition.

After some time spent in preparation of plans, special apparatus and instruments for the tests, in the organization of the working force, and in general arrangements, the Railway Test Commission of the St. Louis Fair has for several weeks past been engaged in the tests of various types of electric railway apparatus submitted for investigation. This Commission is made up of several electric railway experts and is one of the several activities connected with the Department of Electricity of the St. Louis Fair. Prof. Henry H. Norris, of Cornell University, is superintendent of tests, and associated with him are Prof. Hylon T. Plumb, of Purdue University, and Prof. V. V. Swenson, of the University of Wisconsin. These gentlemen are ably assisted by a corps of observers made up of technical graduates of these several institutions.

The instruments used in the various tests were for the most part furnished by the several instrument makers and are of the very highest class. After each test these instruments are calibrated by the standard instruments in the Bureau of Standards, in the Electricity Building. For the shorter tests, requiring no extended runs, a section of test track has been erected alongside the Transportation Building, representing the highest type of track and overhead construction. Here tests of motor tractive efforts, controlling systems, etc., are conducted. Among the first tests carried out were investigations of the action of alternating current in rails of standard section. Currents of various strengths and frequencies were used, and minute measurements were made to determine the amount of power consumed in the rails. These tests were conducted in the Palace of Electricity, in the space occupied by the exhibit of the Bullock Electric Company.

Among the most interesting and useful tests made by the Commission are those of the air brake system used on the St. Louis street railway. The St. Louis Transit Company uses the storage air brake system exclusively on its cars, and its equipment is the largest installation of its kind in the world. Briefly described, this system is one in which air at high pressure is carried on each car, and applied to the brake at a reduced pressure. The storage tanks are charged at intervals from compressor stations located at convenient points along the line. Each car is equipped with the standard brake of the Westinghouse Traction Brake Company. The air is compressed in the stations by motor driven compressors built by the Ingersoll-Sergeant Drill Company, of New York. Most exhaustive tests were made on this system by the Commission, and the results secured will be among the most valuable included in their final report, because they will represent the performance of the system and apparatus under conditions of actual daily service.

The Park avenue line of the Transit Company was chosen as being representative of the city conditions. The cars of this line are charged from a compressor station located at the end of the line, near Shaw's Garden. This station contains two Ingersoll-Sergeant compressors, and is representative in general arrangement of all stations of the system. The test of this station extended over more than thirty-six hours, the observing corps being divided into shifts of twelve hours each. Profs. Norris and Plumb alternated in personal direction of affairs. In the course of the test, records were made of the total volume of air compressed by each machine and the total watt-input of power required for the compressors; a log of varying pressures on storage tanks a record of the pressures on each car and the volume of air consumed by each car.

Minute observations were made of the temperatures and pressures of air at all stages, from compressor intake to car tank; of temperatures of cooling water of the varying voltage impressed on the compressor motors from the trolley line. The efficiency and temperatures of the motors was also carefully measured. Readings were made at close intervals and the recorded observations run into the tens of thousands. It will be a matter of some weeks before the readings are corrected and the results calculated.

The station test completed, the test of the storage brake system was continued in a running test in actual service on a car of the Transit Company. For this purpose Car No. 2600, seating forty-eight persons and equipped with the standard two-truck brake outfit, was selected. The same corps of observations employed, under the direction of Prof. Plumb. The four front seats on one side of the car were equipped with tables for the use of the observers, and on these tables were mounted the various instruments employed. Owing to the severe conditions of service operation, personal observation could not be relied upon and recording instruments of standard type were used wherever possible. Among the records made were observation of air pressure in storage and service tanks and in brake cylinder; the number of stops and brake applications, with pressure employed each time; voltmeter, ammeter and wattmeter readings in the main car circuit and a log of car speeds as registered by a Boyer Car Speed Recorder connected to the car axle. This car test extended over a full daily run, including the hours of rush and heavy load at night and morning. The car carried passengers as in actual service. The records made in this test were almost as minute and numerous as those of the station test and their standardization and computation of results will be a laborious task of many weeks. But the combined results of station and car tests will be a most complete and valuable epitome of the performance of the storage brake system in actual service.

Another test of air-brake apparatus was made on the same car, No. 2600, the equipment being modified to include a standard car compressor set of the National Electric Company. So far as possible the same instruments were used, in the hands of the same observers. Additional records were made of the power required by the compressor motor and the volume of air compressed. The car was run under the same service conditions, over an equal period of time. The results of this test have not yet been worked out.

The result of these tests, made as they were on a standard car of a great traction system, over city tracks, and under conditions of daily passenger service, will be of greatest value to the managers and engineers of railway and manufacturing interests throughout the world. They will be universally accepted as accurate, reliable and free from all prejudice, and the conclusions reached will be recognized as final. The complete report of the Railway Test Commission will be the most valuable contribution to electric railway literature in recent years. The tests now under way and in contemplation include investigations of various types of motor, various systems of control, various designs of truck and equipment. A most interesting feature will be a high-speed test of a car of the Indiana Union Traction Company, on a stretch of track of that company in Indiana. During this test investigations are to be made into braking, tractive effort, and effect of wind pressure at high speeds.

During the air brake tests on the St. Louis Transit Company system the National Electric Company was represented by Messrs. Tollman and Metzler, the Westinghouse Traction Brake Company by Mr. Kidder; while Mr. Wightman represented the Ingersoll-Sergeant Drill Company of New York.

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## Tunneling with a Shield in London Clay.*

The underground electric railroads or "tube" railroads in London have nearly all been driven through the stiff clay which underlies the ground by the Greathead shield method without air pressure. The Greathead shield consists of three principal parts, the cutting edge, the skin and the cylindrical jack casting. The cutting edge is of cast steel made in three parts bolted together and is of slightly larger diameter than the skin of the shield in order to facilitate the progress of the shield through the clay. The skin consists of a cylinder 6 feet long made up

* Extract from a paper presented to the Institution of Civil Engineers, London, by H. A. Bartlett, and reprinted in the *Railroad Gazette* from the Proceedings, Vol. 156.

of ½-inch steel plates in three sections with butt-joints and ½-inch cover plates extending from the cutting edge, to which it is fastened with countersunk set-screws, to within about 2 feet 9 inches back of the jack-castings, forming what is known as the tail of the shield. The object of the tail is to support the ground above and protect the miners while erecting the tunnel lining rings. The ring of jack-castings is made in six sections bolted together and also bolted to the skin and cutting edge with hardwood packing inserted in the horizontal joints. Besides affording a firm foundation for the jacks these castings greatly strengthen the shield and are indeed its main support. Between the jack-castings and the cutting-edge is a steel diaphragm consisting of two ½-inch plates which give stiffness to the shield and assist in maintaining its circular shape.

The shield is driven forward by eight hydraulic rams or jacks, each 7 inch in diameter, the required pressure being obtained with an air intensifier which is fixed to the shield. This receives air at a pressure of 60 pounds per square inch and intensifies the pressure, forcing water into the rams at a pressure of 2,200 pounds per square inch. A flexible pipe connects the compressed-air main in the tunnel with the shield and the intensifier draws its water from two tanks also fixed in the shield, one on either side. This shield is fitted with an oak grouting-rib made in sections, having strips of leather nailed to its outer edge and projecting about ½ inch beyond the oak rib all around. This ring is held in position by the rams and serves to keep the grout in and to distribute the pressure of the rams evenly over the segments of the tunnel-lining.

The shield is moved forward in the following cycle: A box-heading is driven in advance of the shield, being always kept about 6 feet or 8 feet ahead of it. The heading is 6 feet high and from 5 feet to 6 feet wide and is timbered with 4-inch by 4-inch head and side-trees. Two miners and two laborers work continuously in the heading even while the shield is being moved forward and they are able to just keep pace with it. Just before the shield is moved forward, the last lining ring is grouted up, the grouting ribs being held in place by the rams. The clay ahead of the shield is roughly trimmed to the shape of the cutting-edge for a distance of about 20 inches in front. Piles or cutting boards, 6 inches by 1¾ inches by 3 feet long, sharpened to a point and shod with iron at one end are then placed in front of the shield and projecting out into the bank of clay as shown in the illustration. The number of these piles which are used varies with the nature of the ground; their purpose is to bring down the greater part of the clay as the shield moves forward. Small pockets are formed in the clay, just large enough to support the pointed end of the piles until the shield starts. The first two rows of the heading lining are knocked away and laid across the entrance of the heading to keep the clay from falling into it as it is brought down by the piles. Planks are laid from the heading to the platform of the shield to keep the loose clay from falling into the invert. The shield is given its full stroke of 20 inches without stopping unless going around a sharp curve in which case it is stopped at half-stroke to check its position.

The shield having reached the end of its stroke, the rams are drawn back, the grouting rib is removed and the invert of the tail of the shield is cleaned out ready to receive the segments of the tunnel lining. While the shield is going forward the cast-iron segments for the ring, with the necessary bolts and packings, are brought forward on trolleys. The two bottom segments are placed in position on the skin and are bolted to the last ring erected, packings having been inserted in the joints. The packings are creosoted deal and are cut to the shape of the segment flanges with holes bored for the joint bolts. They vary in thickness from ⅜ inch upwards, thicker packings being necessary when going around curves. The next two segments or "side plates" are then lifted into position on the bottom plates and are similarly bolted to the last ring. Meanwhile, two miners, using the heap of clay in front of the shield as a platform have trimmed off the clay around the upper half of the cutting edge for a distance of 20 inches ahead of it, and have placed the cutting piles in position ready for the next advance. A temporary staging about 4 feet above the rail level is erected just back of the shield and the top segments and the key are lifted into

position and temporarily propped, being forced about 1 inch higher than their final position in order to give sufficient clearance for fixing the key in place. When the key is in position the temporary props are removed, the packings are inserted and the whole ring is bolted up. The remaining sections of the grouting-rib are then placed in position and the rams are forced out to hold them. The ring is then thoroughly grouted with lime or cement under a pressure of 60 pounds per square inch. As soon as the ring is bolted up, the temporary stage is removed, and the clay brought down by the piles is loaded into skips and run back to the shaft. When all the loose clay has been removed the miners trim to test the shield for position in line, the two plumb-lines are allowed to hang in the tunnel, and the centre-rod is placed in position in the shield. If the saw-cut on the centre-rod is in exact alinement with the two plumb-lines, the shield is in its correct position as to line; if it is found to be out of line, it must be brought right again by using more rams on one side than on the other. When going round a curve, a table of offsets for every foot of length is compiled. A mark is made on the centre-rod at a distance from the centre saw-cut equal to the offset for the particular point as given in the table, and this mark is brought into alinement with the plumb-lines.

FORCE REQUIRED TO DRIVE A SHIELD IN TUNNELING THROUGH LONDON CLAY.

| Shield Diameter. Ft. | Shield Diameter. Ins. | Shield Circumference. Feet. | Rams. No. | Rams. Diameter. Inches. | Rams. Pressure. Lbs. per sq. in. | Pressure. Total Forward. Tons. | Pressure. Total Back. Tons. | Pressure. Resultant Forward. Tons. | Pressure per Foot-Run of Cutting edge. Tons. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 5¾ | 42.3 | 8 | 7 | 2,240 | 307.8 | .... | 307.8 | 7.3 | Maximum obtainable. |
| .. | .. | .... | 6 | 7 | 1,680 | 173.1 | .... | 173.1 | 4.1 | Piles used. |
| .. | | .... | 8 | 7 | 1,800 | 247.4 | .... | 247.4 | 5.8 | Piles used. |
| 22 | 10 | 71.75 | 22 | 7 | 2,240 | 847.0 | .... | 847.0 | 11.8 | Maximum obtainable. |
| .. | .. | .... | 15 | 7 | 1,176 | 303.0 | 91.8 | 211.2 | 2.9 | No piles used. |
| .. | .. | .... | 16 | 7 | 1,170 | 321.6 | 91.8 | 229.8 | 3.1 | Piles used. |
| .. | .. | .... | 18 | 7 | 1,150 | 356.4 | 91.8 | 264.6 | 3.7 | Piles used. |
| .. | .. | .... | 19 | 7 | 1,100 | 359.1 | 91.8 | 267.3 | 3.7 | Piles used. |
| .. | .. | .... | 19 | 7 | 1,145 | 374.3 | 91.8 | 282.5 | 3.9 | Piles used. |
| .. | .. | .... | 20 | 7 | 1,000 | 344.0 | 91.8 | 252.2 | 3.5 | Piles used. |
| .. | .. | .... | 20 | 7 | 1,160 | 400.0 | 91.8 | 308.2 | 4.3 | Piles used. |

NOTE.—Pressures are given in long tons of 2,240 lbs.

off the clay in the invert ahead of the shield, and the first two settings of the box-heading are knocked away preparatory to the next stroke of the shield.

Two sets of apparatus are used for guiding a shield, in order to control its movement, in respect to (1) line, and (2) level.

(1) Its movement in respect to line is controlled as follows: Two plumb-lines are suspended from the top of the tunnel, about 30 feet apart, the forward line being about 12 feet from the shield. These two lines are hung exactly on the centre line of the tunnel if on a straight stretch, or on the tangent-line if the tunnel is on a curve. The shield is fitted with a removable centre-rod, which can be fixed in two brackets on the back of the shield. On this centre-rod a saw-cut is made, exactly in the centre. In order

(2) For checking the position of the shield in respect of level, two adjustable boning-rods are bolted to the roof of the tunnel, about 30 feet apart, the forward rod being about 10 feet from the shield. The cross-pieces on these rods are adjusted to the required height by means of a level, and a fixed mark is made on the shield. If the shield is at its correct level this mark should be exactly in alinement with the tops of the two cross-pieces in the tunnel. If it is not, the level of the shield must be adjusted by putting more power on the top or bottom rams as required.

In a method of guiding the shield introduced by Mr. H. H. Dalrymple-Hay, two guide-rods, each about 25 feet long, are fixed to the shield on its horizontal diameter, one at each side. These guide-rods are graduated in feet and inches and

are drawn forward by the shield past two "zero-pieces" or indexes fixed to the sides of the tunnel. As the shield advances in a straight line, the readings on both rods should of course be the same. If they differ, one side of the shield is gaining on the other and the shield is going "off line." For going around curves, a special shrunk scale is calculated for the inner side of the curve and marked on the inner guide rod so that the shield is guided on the curve by keeping the scale readings the same on both rods. With methods such as these it is fairly easy to keep the shield within 1 inch of its correct position.

The force required to drive a shield depends, of course, on the nature of the soil through which the tunnel is being driven. The table on page 3166 shows the force required to drive a shield through the London clay. The figures have been taken from actual observations and under varying conditions. The first three sets of observations apply to a shield 13 feet 5¾ inches in diameter and the remainder to a shield 22 feet 10 inches in diameter. In the case of the larger shield, the back pressure exerted by the six table-rams, each 7 inches in diameter, has to be deducted.

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## Compressor Plant for Pneumatic Tools.*

Answering yours of the 19th, will say that while we do not manufacture compressors for as small capacities as referred to in your letter, for operating from one to four pneumatic tools, which we assume to be the small hand tools used by stone cutters, we can perhaps give you some ideas in general regarding the installation, cost of operation, etc.

The type of compressor selected will, of course, depend upon local conditions, as to whether it is direct driven by steam, belt from a line shaft, gas engine or electric motor.

The compressor should be located in a separate building from the cutting shed, if possible, or, if it must be located in the shed, it should be placed in a separate room, which is fitted with tight partitions to keep out the fine stone dust, which is very destructive to moving parts of machinery.

The inlet opening of the compressor cylinder should be piped to a point outside the building, and the opening so situated that cool air, as free as possible from dust and moisture, may be furnished to the compressor. The opening should be covered by a fine wire screen of sufficient area, so that the free flow of air is not interfered with.

The compressor cylinder should be fitted with a water jacket through which a sufficient quantity of cool water should circulate at all times, to prevent undue heating of the cylinder, valves, etc.

Whatever type is selected, it should have a reliable governor or unloading valve, which will stop the compression of air when the receiver pressure has reached the desired limit, and thus save unnecessary waste of power by the escape of air through the safety valve.

The discharge from the compressor should be piped to a receiver of ample size. The receiver is not intended as a storage reservoir for power, but is necessary to maintain a uniform pressure in the pipe lines and avoid the pulsations due to the intermittent discharge from the cylinder. The receiver should be provided with safety valve, pressure gauge and drain cock for removing oil and moisture which may precipitate in it.

The cylinder and all bearings should be provided with suitable automatic sight feed oil cups. For oiling the cylinder only the best grade of compressor oil, of high flash test, should be used. A low flash oil, or oil containing mineral or vegetable fats, should not be used under any consideration in the air cylinder, as this oil is certain to become carbonized and will be deposited on the discharge valves, causing them to stick and give trouble. The heat of compression has frequently been known to ignite a poor oil and cause explosions, bursting the receiver or blowing off the air cylinder heads. A very small quantity of oil should be used in the air cylinder, about one drop per minute being all that is necessary.

If a steam-driven compressor is decided upon, the cost of operation would be figured out something as follows: About 65 pounds air pressure would be necessary at the compressor. Each cubic foot of air compressed would require at the power end of the compressor .173 horse-power. Each pneumatic tool ordinarily requires about 8 c. f. of air per minute, which

* By F. D. Holdsworth, in *Granite*.

would therefore require 8 x .173, or 1.30 H. P. for each tool used. Each horse-power developed in the steam cylinder of a small size compressor would require about 7½ pounds of coal per horse-power per hour, and assuming that the tool was running 60 per cent. of the time, the pounds of coal required per year of 300 ten-hour days would be 1.39 x 6 x 300 x 7.5, which equals 18,750 pounds of coal per year, or 9.4 tons per year for the operation of one pneumatic tool. This, at $4 per ton, would represent $37.60 per year for coal.

If the compressor was belt-driven and received its power from a line shaft driven by a good-sized and fairly economical engine, the cost of coal would be only about 65 per cent. of the above or about $25 per year for each tool.

If a gasoline engine is used, and allowing that a horse-power can be developed on the expenditure of 1-10 of a gallon of gasoline per horse-power per hour, by pursuing the same method of calculation, it will be seen that the cost for operation by this method per tool would be about $30 per year, with gasoline at 12c. per gallon.

If the compressor is operated by an electric motor and the current bought from an outside power company, which can be obtained for prices ranging from $25 to $45 per year per horse-power, the cost of operation by this method would amount to approximately $35 to 62.50 per year for each tool used.

The expenses for oil, waste and repairs ought not to be over $30 to $35 per year. Plants of such small capacities as you mention can readily be attended to by one of the foremen or employees, so that the cost for attendance would amount to very little. We have a number of plants in successful operation in cutting sheds in Barre and Montpelier having capacities of 140 to 600 feet of free air per minute.

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## A Stay-Bolt Drilling Machine.

A machine for drilling tell-tale holes in stay-bolts, used in the Union Pacific Railroad shops at Omaha, is described and illustrated in a recent issue of the *Railroad Gazette.*

A discarded pipe-cutting machine was reclaimed from the scrap pile and equipped with two parallel shafts having sockets at each end for drill chucks. These shafts are mounted in suitable bearings and are provided with ball-bearing collars which act as thrust bearings to reduce the friction from pressure on the drills.

At each end of the machine are two air cylinders formed side by side in one casting. On the end of the piston rod of each are two small chuck jaws with a spiral spring between, which holds them apart normally. These jaws grasp the stay-bolt at one end. The piston rod, which is hollow, is also an air cylinder, the piston of which moves a wedge for closing the chuck jaws. The supply pipe for this latter cylinder passes through a stuffing-box at the back of the larger cylinder and moves back and forth with the piston of the latter, a flexible connection on the outside permitting this. Between the air cylinders and the drills are guide blocks. These are pneumatically operated and are equipped with V-shaped guides capable of being adjusted to suit the different diameters of bolts. The drills are lubricated by means of oil reservoirs. The oil is returned to these reservoirs by means of a rotary pump placed under the bed. The machine can drill four bolts at one time. At the side of the bed and convenient to the operator is a series of air valves for each end of the machine. Two control the supply to the inner or rod cylinders to operate the grasping chuck; two control the supply to the outer cylinders for operating the feed; the other two control the jaws of the clamp guide. The size of the drill used is 3-16 inch, and the depth of the hole is 1½ inch. In the hands of a skillful operator six bolts a minute can be drilled on the machine. The entire process of preparing and applying the bolts is as follows: The iron is first cut off 1 inch longer than is required. The tell-tale holes are drilled and the threads cut, after which the bolts are nicked in a machine at the proper length for cutting off. They are then screwed into place in the sheets from the fire-box side with a special chuck, after which the nickel ends are broken off with a hammer and the ends of the bolts peened.

The stay-bolt drilling machine was designed by W. H. Mulcahy, one of the department foremen at Omaha. He has applied for a patent on it.

## Changes in the Baltimore & Ohio Locomotive Pick-Up Device.

The sectional third-rail system installed on the B. & O. belt line and described at length by W. D. Young in the *Street Railway Journal* of March 14, 1903, has recently been slightly changed by the installation of an improved pick-up compressor on the cab. The readers of the previous article will remember that the system employed is that of the Hopkinson switch, using a high-voltage pick-up bobbin and a series hold-up bobbin. For picking up the switch there must, therefore, be a source of high potential on the cab, and one independent of the power house. In fact, one of the features of the B. & O. system is the fact that a source of high potential has been obtained in a reliable manner without the addition of any large quantity of auxiliary apparatus. This is accomplished by using an electric motor air compressor, either in its normal function as an air compressor for the brakes or as an air motor. In this service it takes air from the tanks and drives its motor as a dynamo, thereby supplying the necessary pick-up current, and also the lights for the cabs at such times when the rail section upon which the shoes are resting is dead. This compressor, which has recently been redesigned, is of the Christensen type, and was built by the National Electric Company. It is illustrated in Figure 1.

It is a geared machine, carrying a motor on the top, the compressor proper being below. The latter has three cylinders, so that there will be no dead centre in starting, as an engine, and it is equipped with poppets in the ordinary way, the engine portion of the equipment being provided for in the shape of a revolving valve, which is driven by spud gearing from the main compressor shaft in the same direction and at the same speed. This valve shaft can be moved to the right or left, and in one position admits and exhausts air in engine time, and in the other is out of commission. The valve shaft is provided with a spline, which slides back and

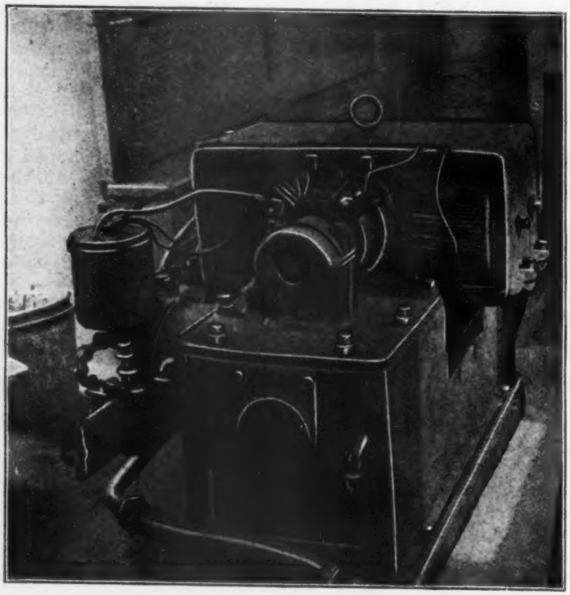

FIG. 1.—ELECTRIC MOTOR AIR COMPRESSOR.

forth through an appropriate key in the driving gear. The motion of the valve shaft is controlled by an air cylinder, shown at the right of the figure and in Figure 3. Air is admitted or exhausted from this cylinder by means of a sliding valve, D, controlled by an electro-magnet, E, also shown at the right, and above in the photograph, Figure 1. This magnet is wound with two coils, a shunt and a series coil, the shunt coil being in series with the shunt field of the magnet and a series coil in series with the armature. When the magnet is de-energized, the sliding valve adjusts the air ports and admits air to C, moving the piston, P, and the valve shaft, R, so that engine position will be assumed by the latter when the air is supplied to the apparatus. As soon as the magnet has re-received energy from both its shunt and series coil, the sliding valve shifts so as to vent the cylinder, C, and the spring shifts the valve shaft to compressor position.

The operation is as follows: Assume the engine to be resting on a third rail, which is disconnected from the power house or dead; that the tanks are full of air, and that the compressor also is at rest. Air is admitted to the compressor, and the magnet, E, being de-energized, the valve is at once shifted to engine position, the machine starts as an armature and rapidly builds its dynamo up to voltage. The circuit connecting the compressor to the electric lines is then closed. As the air pressure reduces, due to the demands of the compressor upon the tank, the pump governor closes its circuit also. This completes a circuit of the compressor from third rail to ground, and raises the potential of the third rail to 550 volts and immediately picks up the sectional track switch. As soon as this occurs, current from the third rail enters the compressor system and proceeds to drive the machine as a motor. The magnet, with its additional excitation, now readjusts its sliding valve, and the valve shaft now moves to compressor position, and the machine now compresses air. This it continues to do until the tanks have been pumped up to 90 pounds, or to

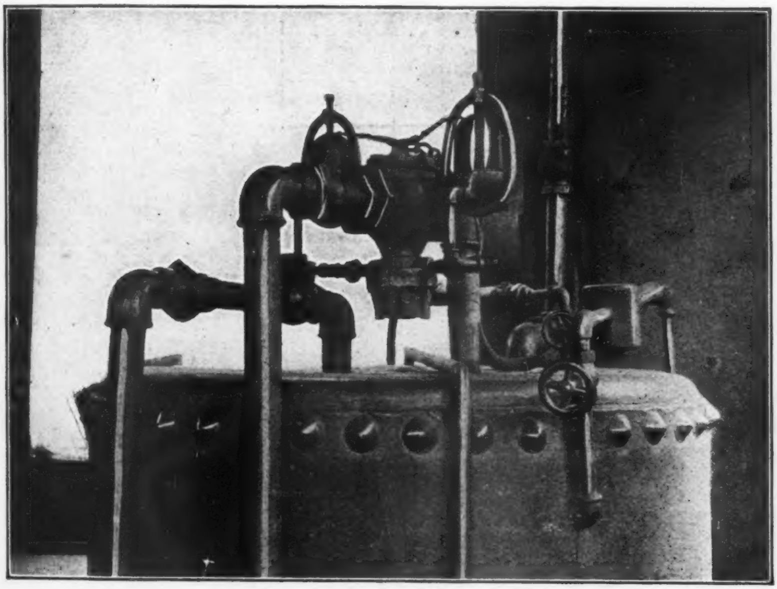

FIG. 2.—COMPRESSOR TANK AND PIPING.

whatever pressure the pump governor is set. At this instant, the pneumatic governor flies open, the sliding valve drops, and the machine becomes an engine and runs as such for a brief period until the cycle of operation is repeated. If the locomotive is running, the sectional track-switch will, of course, not drop, for it is held up by the locomotive current in the series coil, but this will make no difference in the behavior of the compressor, whether it be on a permanently live or on a sectional rail.

he have complete control of both the air supply and the electric supply. The latter is easily provided for by means of a switch at his station. The air supply, however, is controlled electro-pneumatically. An automatic air valve is placed on the tank. This air valve is shown in Figure 2. On the right and left of this air valve are two bobbins, which open needle valves which control a piston which operates a main valve. The needle valves are controlled by a dry battery, operated by two buttons at the motorman's stand, one of which will open and

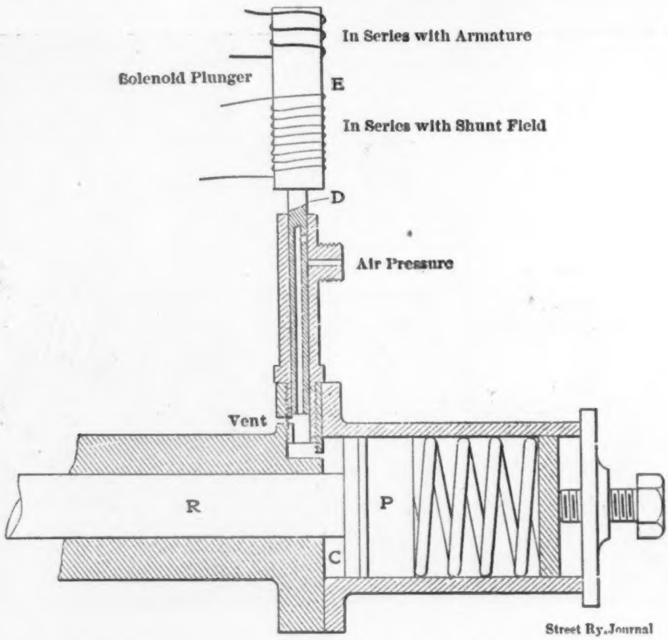


FIG. 3—ELECTRIC CONTROLLING MECHANISM OF AIR COMPRESSOR.

When the locomotive is drifting over sections, it is highly important that current shall always be available to the motorman; therefore, the sectional switch must be kept up, and for this purpose the compressor current is sufficient. If for any reason the switch should happen to drop, due to jar, it will instantly pick up again, because the compressor keeps the rail at a voltage equivalent to that of the line.

In order to control the compressor from the motorman's stand, it is necessary that

the other close the main valve. If the motor is resting on a dead section, and the motorman desires to start, he presses the starting button. This admits air to the compressor and operates it as an engine. He then closes his compressor circuit, and his switch presently picks up coincidently with the closing of the pump governor. He is then free to start and stop his locomotive as he pleases, whether the section that he is on be controlled by a sectional switch or not. Having finished his trip

and desiring to stop permanently, he brings his locomotive to rest in the ordinary way, opens the compressor circuit and presses the closing button on the air-valve system. This brings the compressor to rest, having cut off both of its sources of energy, and leaves him with air in the tank for starting purposes again.

The valve of the apparatus will be appreciated when it is seen that it is a rugged machine of large capacity, which is capable of picking up the switch in spite of any leak which may be upon the rail. The compressor shown in the figure will deliver for an instant as high as 30 amps. at 550 volts.

When a sectional rail leaks to an extent exceeding 15 amps., it begins to give ample notice of its condition, and is so troublesome in any event that it should be corrected, and this being the case the apparatus described is able to cope with any leakage conditions that may be found in practice. The only additions to the regular locomotive equipment are the automatic valve for controlling the compressor air and the additional valve shaft and shifting piston installed upon the compressor itself. The remainder of the equipment must be had in any event in the ordinary third-rail system.

The compressor is so designed that the engine equipment in no way interferes with the operation of the machine as a compressor. It could be totally disabled and the machine would still be compressor operative. The loss of pressure in the reservoir does not affect the Westinghouse air-brake system, to which it is connected, for the reason that the latter is connected to auxiliary tanks separated from the air entering tank by a check valve. The first tank forms the reserve supply for the compressor, and the pressure in the tanks to which the air-brake system is connected is therefore not reduced by any demands the compressor may make upon the air system for its engine duty. The speed of the compressor as an engine is entirely independent of its compressor performance.

By suitable adjustments controlling engine mechanism, the compressor voltage can be raised from 400 volts to 1 000 volts, regardless of whatever the line voltage may be. It is therefore able to pick up switches that may have bad contacts in the shunt circuits of sufficient resistance so that the line voltage would not be able to operate them. The apparatus has given very satisfactory results in its recent performance and bids fair to give commercial satisfaction in the future.—*Street Railway Journal.*

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### Air Brakes in Street Car Service.*

At the Detroit meeting of the Air Brake Association a valuable report on the use of the recording gauge in air brake service was presented by Mr. George R. Parker, chairman of the committee having the subject in charge. The charts submitted with the report were, however, confined to those taken from train pipe pressure. In a committee report to the convention of 1900, on handling of trains

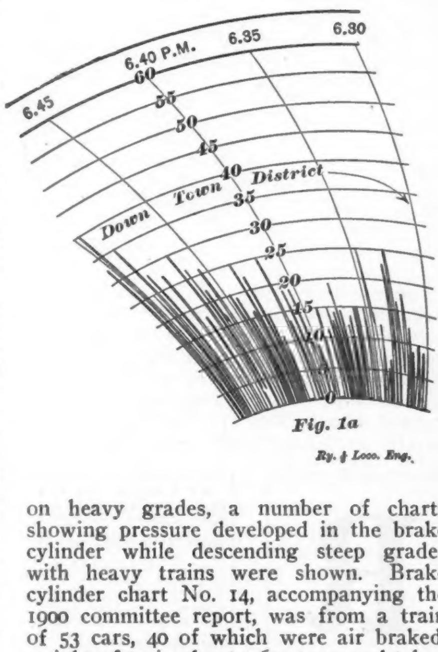



*Fig. 1a*

Ry. & Loco. Eng.

on heavy grades, a number of charts showing pressure developed in the brake cylinder while descending steep grades with heavy trains were shown. Brake cylinder chart No. 14, accompanying the 1900 committee report, was from a train of 53 cars, 40 of which were air braked, weight of train about 1,600 tons, and taken while descending a grade of about 2 per cent. Examination of the chart mentioned shows some 14 brake applications during a period of 30 minutes and represents severe grade conditions.

Some time ago the writer had occasion to take some brake cylinder charts from street cars operating in city service, and,

* By C. P. Cass, of St. Louis, Mo., in the Air Brake Department of *Railway and Locomotive Engineering.*

believing the results obtained would prove interesting to air brake men generally, send you herewith these charts for comparison with steam road practice.

A connection was made in the brake cylinder direct, with suitable rubber tubing, carried into the car where the recorder was located.

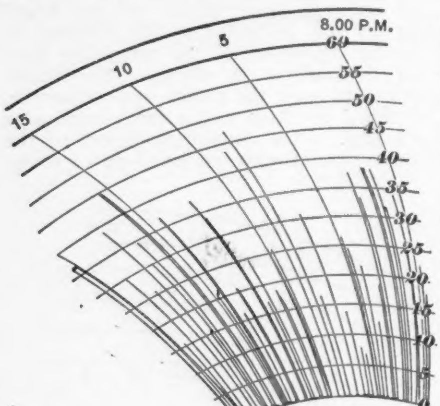
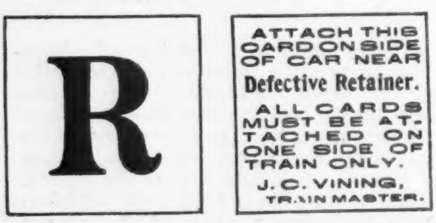



*Fig. 2*

*Ry. & Loco. Eng.*

The car was fitted with a straight air brake, and pressure carried in the main reservoir would permit of a cylinder pressure of 60 pounds if desired.

The car entered service at about 3.27 P. M., at which time the recorder was cut in (see Chart No. 1), and allowed to operate unitl 6.23 P. M., when the chart




DEFECTIVE RETAINING VALVE CARD USED ON COLORADO MIDLAND R. R.

was removed. The speed of the chart was three hours for a complete revolution.

The number of brake applications made during this period of three hours was between 370 and 380; those occurring between 5.30 and 6.00 P. M., when the car was in the downtown district during the busy hours being particularly close together. Many of the applications were in the nature of slowdowns for teams, pedestrians, crossings, etc., but serve to indicate what the street car motorman is "up against" when using a hand brake.

It is interesting to note the highest cylinder pressure obtained on Chart No. 1 was 45 pounds, and that but once, indicating skillful handling on the part of the operator.

Chart No. 2 was taken between the hours of 6.30 P. M. and 8.45 P. M., and, on account of reduced passenger travel, shows less applications for a given time. It will also be noticed a higher average of cylinder pressure was employed after 8.00 P. M., this being due, no doubt, to darkness having fallen and, therefore, less chance to judge speed and points at which the stop was desired.

Chart No. 3 was taken between the hours of 9.15 P. M. and 12.10 A. M., at which time the car was turned into the shed. During the taking of the latter card the speed was slower, owing to the fewer stops required and generally low pressures were used.

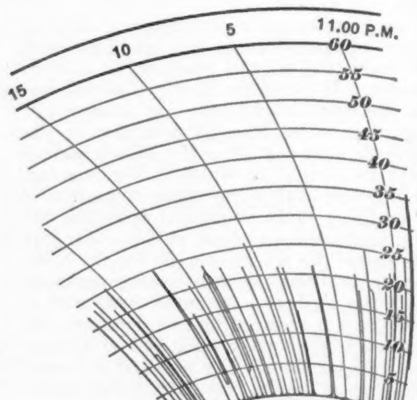



*Fig. 3*

*Ry. & Loco. Eng.*

As a matter of further interest it might be said that the car weighed approximately 34,000 pounds, and was braked about 90 per cent. of the estimated weight, based on 60 pounds cylinder pressure.

Before starting the experiment, the pis-

ton travel was adjusted to 4¾ inches standing, and again measured after the nine hours' run, the travel having increased to about 5¼ inches. The shoes with which the car was fitted were ex-

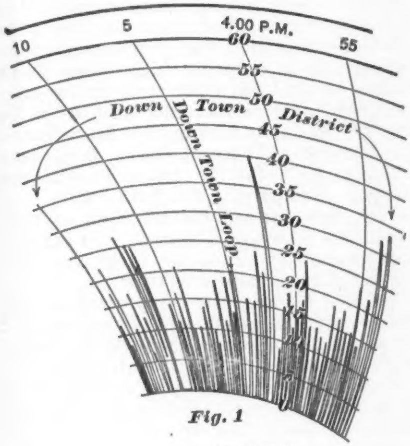



*Fig. 1*

*Ry. & Loco. Eng.*

tremely hard, and the brakes being applied but a few seconds at each application, accounts largely, no doubt, for the small amount of brake shoe wear.

## Compressed Air in Electric Railway Work.—III.

It having been determined that compressed air is a desirable adjunct in electric railway shop work, the choice of a suitable compressing plant becomes a matter of selection from the many reliable types of compressors on the market. The compressor may be driven by steam engine, either direct connected or by belt, but for electric car repair shops the electric motor-driven compressor is undoubtedly the best form to use. For general use in electric railway shops and power houses, a pressure of from 75 pounds to 100 pounds per square inch in the main reservoir tank will be found to meet practically all conditions. It is seldom that the higher pressures will be required, and if lower pressures are desired (as for instance, for cleaning purposes, where 20 pounds would be found advantageous) the air can be taken through a reducing valve.

For very small installations where the air is to be used chiefly for blowing and cleaning purposes, and where pressures above 75 pounds will not be necessary, a single-stage compressor, driven by a small motor, will probably do the work. It should be borne in mind, however, that a single-stage compressor is not economical in its action, and though somewhat less expensive in first cost than a two-stage or compound machine, a two-stage compressor will give far more economical and satisfactory results. When air is compressed its temperature is rapidly increased, and when compressed to 75 or 100 pounds in a single-stage compressor, the rise in temperature will be sufficient to seriously interfere with the operation of the plant. These difficulties are not encountered to the same extent in a compound compressor, because the first cylinder compresses its charge to about 30 pounds only, the temperature due to this pressure being 200 to 260 degrees F., which is comparatively low and harmless. The air continues its way to the next or high pressure cylinder, and is usually passed through a cooling device, so that it enters the second cylinder comparatively cold at 30 pounds pressure. The temperature due to the compression in the second cylinder from 30 pounds up to 100 pounds, is not likely to be over 200 to 250 degrees, and the effects of this heat can be overcome by proper water cooling jackets around the cylinders.

For service in electric railway shops, where the air will seldom be used continuously for long lapses of time, a comparatively small compressing outfit with storage reservoir of sufficient capacity will usually fill all requirements. A shop built to care for 750 or more cars, where the air is to be used for several of the classes of work to which it is applicable, should have a compressing plant capable of compressing about 75 cubic feet of free air per minute to 100 pounds pressure. However, for a smaller shop, a compressing plant having a capacity of from 10 to 20 cubic feet of free air per minute will give sufficient air for all ordinary cleaning purposes, for blow torch and sand blast uses, and for a limited number of pneumatic tools, providing the air is not to be used for all these purposes at the same time. Any of the accepted types of compressors, such as those furnished by the Ingersoll-Sergeant Drill Company, are available for this class of work. If, in addition to, or in place of, a permanent stationary com-

pressing outfit, it is desired to have a portable compressing plant, it can be selected from the products of the National Electric Company, of Milwaukee, or the Westinghouse Company. Both of these concerns make very compact and serviceable compressing outfits, which include a compressor and storage tanks mounted on a low truck, and which can be moved readily about the shops to accommodate the work that is to be done.

Concerning the cost of installing a plant for giving air under compression, it may be said that the expense of a complete outfit will run from $350 up, according to the size of plant and use to which it is to be put. As to the cost of running the plant, Mr. E. C. Boynton, a prominent compressed air engineer, gives us the following data: "I have figured the approximate cost of compressing 1 cubic foot of free air from 0 to 90 pounds. The recent tests at the Boston Elevated Railway shops show the average power required to compress 5¼ cubic feet of free air from 0 to 90 pounds is (by the Christensen compressor) 269,563 watt-seconds. Dividing this by 60 twice gives 750 watt-hours, and again dividing it by 1,000 gives .750 kilowatt-hours. A fair average cost of power at the switchboard of a power station is 0.75 cent per kilowatt-hour, or allowing for various losses, a fair cost is, say, 1 cent per kilowatt-hour. It would cost, therefore, 0.75 cent to compress 5¼ cubic feet from 0 to 90 pounds. Dividing by 5¼ we have 0.14 cent as the cost of compressing one cubic foot to 90 pounds, or a little less than 1½ mills." Another engineer states that in running tests on a motor-driven compressor rated at 11 cubic feet of free air per minute, he has frequently pumped 5 cubic feet of air to 75 pounds pressure in 2½ minutes, the motor taking about 4 amperes at 600 volts. These are probably average figures, and the cost of power being known, the expense of compressing air for any particular installation can be estimated closely.

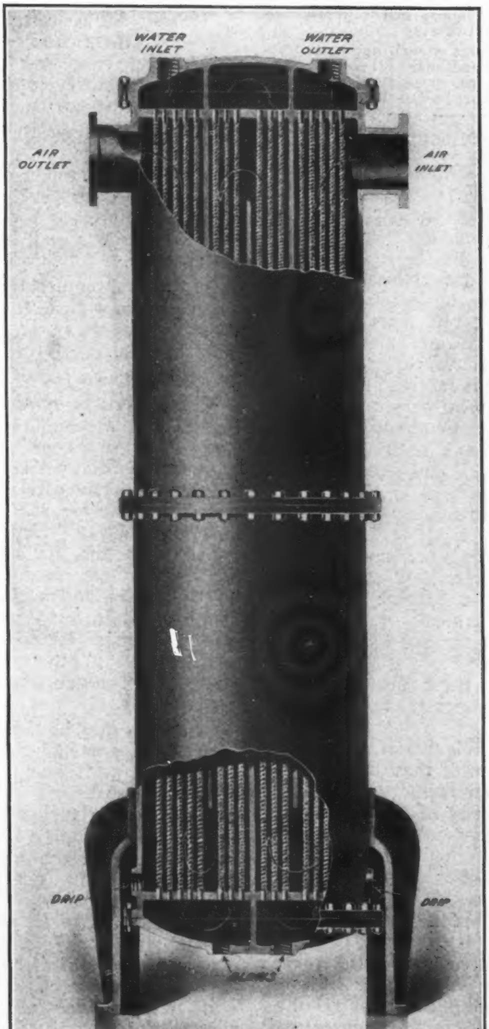
The transmitting of air under compression to various points of the shop or even to adjacent buildings involves no serious engineering difficulties, as the losses from friction and condensation for distances up to 1,000 feet are practically nil, and providing reasonable care is taken to make the transmission pipe air-proof, the losses may be entirely disregarded for installations of the kind under discussion.—*Street Railway Review.*

## The Taunton Compressed Air Cooler.

In using compressed air it is important that its temperature should be reduced before it is passed to the storage tanks, as there is considerably more energy in a cubic foot of cool air than in the same volume of hot air. Air, as it leaves a compresser, is at a rather high temperature, owing to the heat generated during compression. To extract this heat from the air, the Taunton Locomotive Manufacturing Company, Taunton, Mass., designed a heat extractor for the American Waltham Watch Company, Waltham, Mass., in which they applied the principle of their even flow feed water heater. The illustration herewith shows the form and construction of the new extractor.

As will be seen, the compressed air and the water flow in opposite directions, and both make four passes through the cooler. The advantage of the countercurrent is that it accomplishes the cooling more gradually and hence effectively. The extractor is divided by vertical partitions to cause the four passes of the air, and in the four chambers are the copper water tubes. The latter have corrugated surfaces which increase the area of contact, and break up the flow of water in a manner such that the maximum heat extracting effect is obtained. If the ordinary smooth surface copper tubes were used the water in flowing through them would become a fluid pencil with heated outer surface and cool core, thus wasting a good deal of the cooling effect of the water. The old way made use of one large group of tubes, through which the water was permitted to slowly make its way up through the chamber. In this new heat extractor, just as in the even flow feed water heater, the flow of water is increased by dividing the tubes into groups and sending the water through a few tubes at a time, thus obtaining greater velocity of the water. As is well known, the greater the velocity of the water the greater its heat extracting power. The improvements summarized are the use of the countercurrent of water against air; the high velocity of the water, and the use of corrugated surfaces in the tubing.

The extractor at the Waltham power plant has been operated to cool 1,450 cubic feet of air per minute from 230 to 65 degrees F., and in so doing heated 5½ gallons of water per minute from 55 to 180 degrees F.—*The Iron Age.*




VIEW OF THE TAUNTON COMPRESSED AIR COOLER WITH PARTS BROKEN AWAY TO SHOW THE TUBES AND THE COURSE OF THE AIR AND COOLING WATER.

## COMMUNICATIONS.

**Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.**

**We request that the rules governing such correspondence will be observed, viz.: all communications should be written on one side of the paper only; they should be short and to the point.**

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*The Editor of* COMPRESSED AIR:

SIR—I have read with interest the abstract of paper by Mr. E. Goffe on "The Causes of Explosions in Air Compressors," which appeared on page 2976 of your June issue.

I do not wish to traverse Mr. Goffe's remarks as to how the explosive gases came into existence; but there are three points which appear to me (a designer of mechanically operated valve gears for air compressors) of great interest.

1st. That a mechanically operated valved compressor, in the two specific cases quoted, appears to have been the one to fire the explosive gases, and not the simple lift valved compressors.

2d. That explosions took place with stage compressors.

3d. That in some cases ordinary machine oil is used without fear.

In the first of the specific cases the r. p. m. of the mechanically valved compressor were 68, and the lift valved compressor were only 25.

In the second case the r. p. m. are only given for the mechanically valved compressor.

Comparing the two classes of valves, the case between them stands that the mechanically operated valved compressor can be run at double the speed of the simple lift valved compressor and with greater efficiency.

It is, of course, obvious that the quicker the revolution the less the heat abstracted by the water jacket, but it is not so obvious that the final temperature rises in proportion to the quickening of the revolution, for the intake air has less time to get heated at the high number of revolutions, and thus the final temperature should be less on this account.

The heat abstracted by the water jacket is a small proportion of the heat developed in any case.

I enclose a copy of two diagrams taken at two very different speeds which, I think, fully explains the apparent cause of higher final temperature in compressors as the revolutions increase, even though the heat developed during the compression itself is constant.

It will be seen that the compression curve is identical at two very different speeds, proving that in the compressing itself the heat developed is constant at and between these two speeds.

I find, however, the rise above the receiver pressure is proportional to the square of the number of revolutions.

Of course, it is not good practice to design a compressor for one speed and run it at a higher speed, but I am afraid it is often done.

If the final temperature is to be no higher than the theoretical, the ports and passages must be ample in area, straight and not corkscrewed.

The air chest must be large.

A fault with many mechanically operated valves is that the delivery port is closed gradually toward end of stroke, and it is quite closed and perhaps more than closed at the dead end of stroke, compelling the last bit of air to pass through ports at an excessive speed. But the case is even worse than this, for before end of stroke the air has been passing edge of valve at a high velocity, and in doing this has heated it up to a high temperature; finally, at the very last, more air is forced through at a greater and greater velocity, raising the temperature much above theoretical final temperature.

That this may be the cause of the explosions is supported by the fact that explosions seem as frequent with stage as with simple compressors. In a stage compressor the delivery of air from cylinders takes place through a longer portion of the stroke, and thus the edge of the valve has a longer time to get heated before the partial closing of valve produces the last and greatest rise in temperature by excessive friction.

I also question if the impact of the air at high pressures and quick revolutions will not produce a temperature much above the temperature of the air itself.

The fact that ordinary machine oil is used in some cases without fear also points to some local cause of explosion, such as I suggest.

The lines I have laid down for my own guidance in design are as follows:

(1) The valve gear must be such that the valve opens instantaneously, remains

open during delivery of air and closes instantaneously at end of stroke.

(2) The valve must be capable of lifting off its seat should pressure be excessive during the closing period.

(3) The velocity of air through ports should not be greater than 80 feet per second for intake and not greater than 100 feet per second for delivery.

(4) The valves to be placed in cylinder end and to be of flat grid type, giving straight through ports.

(5) Ample capacity to be allowed on reverse side of valves, so that the air when delivered shall not be thrown with a great velocity against any obstruction.

(6) Every precaution should be taken to make flow of air to and from valve as easy as possible; to this end ports should be bell-mouthed at entrance.

A grid valve with a fair number of ports more nearly approaches the numerous valves required in a lift valved compressor, thus the air comes in contact with a large amount of metal, distributing the heat.

In a poor design quick revolution is a danger, but with a good design I see no reason why a compressor should not run at any speed that the motor can drive it.

After an explosion I should first look to the oil and then to the design of the gear.

Hoping this will prove of interest to your readers, I remain,

Yours truly,

J. A. Coombs, A. M. I. M. E.

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New York, August 28, 1904.

*Editor of* Compressed Air:

Dear Sir—The article in the August number of Compressed Air on the subject of "Electrically-driven Compressors" was indeed timely, and you are to be congratulated on being willing to give space to a discussion of this interesting subject; it is to be hoped that much interesting and valuable information will be brought forth.

The automatic regulation of the electrically-driven compressor, so that it will start and stop of its own accord, depending on the amount of air being used, is an important detail that has not been given the attention it deserves.

For compressors using direct current motors there are two fairly good systems of control on the market, but it is impossible at the present date to purchase a system of control for use with alternating current motors. This is surely worthy of the attention of somebody, as it offers an opportunity of developing an interesting piece of mechanism for which there is surely a good market.

Of course, if practically the full capacity of the compressor is to be used right along, the choking inlet controller will take care of the slight variations of consumption very nicely, and nothing more is needed. Where the service is very intermittent, however, some device that will start and stop the compressor automatically is absolutely necessary, otherwise there will be needless waste of power.

The direct current controllers might also be considerably improved. As at present manufactured, they take up a great deal of room that cannot always be spared, and one type has the additional objections of having constantly moving parts, necessitating direct connection with the crankshaft of the compressor; also the use of a sliding contact for cutting out the blocks of resistance, which, while all right on motors up to 10 or 15 horse-power, is not suitable for sizes larger than these, owing to the excessive sparking from the heavy current that has to be carried.

The requirements of a satisfactory system of control are that it shall maintain a pressure in the air receiver which shall not vary more than 5 pounds above or below normal; that it shall cut out the blocks of resistance when starting by means of positive make and break switches, so as to eliminate all sparking; that it shall not require connection with any moving part of the compressor; that it shall be substantial and need attention only at long intervals of short duration; lastly, that it shall not be costly. The present controllers for a given installation cost over half as much as the motors, which seems excessive. The control system should also be arranged to take care of the supply of water to the jackets and intercooler.

It is quite possible that, in the absence of any form of commercial control for alternating currents, that some good "home made" apparatus has been made, and it is partly in the hope that descriptions of this will be forthcoming that your correspondent is moved to write this letter.

Yours very truly,

J. D. G.

## Notes.

The Newark Pneumatic Puncture Proof Tire Company, of West Kearney, N. J., has been incorporated with a capital of $25,000.

The Columbus Pneumatic Tool Company, of Columbus, O., is building a new brick factory at that city for the manufacture of its tools.

A safety device for elevators has been designed by John J. Schwab, of St. Louis. It operates by compressed air. It is claimed by the inventor to stop an elevator under any conditions.

One feature of the pneumatic tube system connected with the Berlin post office is the use of these tubes for gathering in letters deposited at the letter boxes in the more important sections of the city.

Compressed air is being utilized by the Pennsylvania Railroad wherever possible. Pneumatic hoists are being used to lift the ash cars from the ash pit and for other kinds of service at the round houses.

The National Compressed Air Cleaning Company, of Indianapolis, Ind., has been incorporated there with a capital stock of $50,000. The directors are E. Hale Robinson, E. D. Salsbury and M. E. Traux.

A compressed air blast was used last summer with much success for cleaning the iron work of the Brooklyn elevated railways, previous to painting. The dirt was removed from angles and corners with great success.

Articles of incorporation have been filed by the Globe Pneumatic Tool Company, of Lyons, N. Y. It has a capital of $100,000. The directors are Philip S. Hill, Frank M. Van Wagonen and Frank A. Clary, of New York, and others.

Air compression by water power is one of the suggestions made in connection with the proposed dam across the Brazos River, near Waco, Tex. The compressed air thus developed could be piped some distance and used for operating all kinds of machinery.

The W. J. Clark Company, of Salem, Ohio, has about completed a full set of metal "follow-boards" for molding the parts of different sizes of the "Quick-as-wink" air hose couplers. Such follow-boards are very expensive, but are found economical in the long run in some cases.

A new compressed air painting machine, known as the "Pnumopant," has been introduced into England, where this kind of a machine is considered new. The apparatus consists of a sprayer, paint tank and air compressor. It is claimed that the supply of color can be so controlled as to produce graduated tints to blend the colors.

The attempt to introduce the Batcheller pneumatic tube system into England has resulted in the organization of the British and Foreign Pneumatic Tube Syndicate, Limited, with a capital of £30,150. Its object is to acquire the English patents of the Batcheller Pneumatic Tube Company, and to operate a system of these tubes in London.

The August issue of *Page's Magazine* (Eng.) contains an article on "The Equipment of the Lancaster West Mine," by Edgar Smart, A. M. Inst. C. E. It includes mention of a 20-drill steam-driven air compressor. The machine supplies 2,340 cubic feet of free air per minute, at 82 pounds pressure. It is fitted with the Koester valve gear, with positive inlet and spring outlet valves.

At a conference of the Federated Council of Government Employees, at Chatham, Eng., the question of the danger to health in the use of pneumatic tools was raised. This discussion has caused considerable talk, the general opinion expressed seeming to be that, with proper training, there is nothing dangerous in the use of the tools, while the advantages to be gained by their use are enormous.

The building of the subway tunnel under the Harlem river has been completed and the tunnel turned over to Mr. McDonald for the laying of the track. The construction of this tunnel was on lines differing materially from the others. In the western section the tube was built in a wood and iron box on the bottom of the river, into which compressed air was pumped.

The eastern section was constructed in a floating box. When the tubes were laid the water was pumped out and the compressed air pumped in.

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Readers of Compressed Air will be interested in the series of photogravure illustrations which have recently been issued by the C. & G. Cooper Company, showing a few of the different types of the Cooper Corliss engine. One of these shows a 1,200 H. P. cross compound condensing Corliss engine which has been installed in the power house of the National Cash Register Company, at Dayton, Ohio. Its exact duplicate has just been installed. The C. & G. Cooper Company will be pleased to furnish these illustrations to interested parties.

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An experiment was recently made in Germany to test the durability of liquid air. The manufacture of liquid air for scientific and technical purposes has assumed considerable proportions in that country, so that the question of transportation has become an important one. Two quarts of liquid air, packed in a specially prepared can, were shipped from Berlin to Geneva by rail. An interval of five days passed before the liquid air reached its destination, and one-fourth of a quart of the liquid still remained. With larger quantities the loss would not have been relatively so great.

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The physiological effects of compressed air may be inferred from the following suggestions: Men required to work under compressed air should be sound, small, temperate, and at least twenty-five years old. For a pressure of two atmospheres the shift should not exceed four hours, and the time of passing through the lock on coming out should be thirty minutes; while for a pressure of five atmospheres the length of the shift should be reduced to one hour, and the time in the lock should be twice that amount. After leaving the lock on coming away from their work the men should have a complete rest of one hour.—Chicago *Tribune*.

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Another East River tunnel at New York seems probable, but it will be for gas mains, like the only tunnel now under the river, and not for passengers. Just what the project actually is remains indefinite to those not close to the Consolidated Gas Company, but it is understood that it contemplates a tunnel from Lawrence Point, Astoria, to East One Hundred and Tenth street, Manhattan. A commission to condemn city and State property for the purpose was appointed early last month. The property of the gas company in Manhattan is very valuable, and it has been recognized generally for some time that sooner or later high taxes and other causes would compel the company to give up its gas works in the borough, and pipe gas through tunnels from huge plants on Long Island.

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The postal pneumatic tube system inaugurated in Chicago recently means the saving of from thirty to fifty minutes in the transmission of a letter from the business district of the city to a point like the stockyards or the railway stations. It means that the mails for the trains going east and west can be made up at the post office half an hour later than now. This thirty minutes is that much gain for the business houses.

There is no question about the quick transit of mail in a pneumatic tube. It is inclosed in a caisson and it goes like the wind, but in safety. Extended, the system would be to the advantage of all parts of the city, as mail from all the substations could be sent in a few seconds to the central post office or to the waiting mail trains. Collections could be made with the new service in mind, and the advantage would be to all patrons of the substations within the range of the pneumatic service.—Chicago *Inter-Ocean*.

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The first regular meeting of the season of the American Society of Civil Engineers was held on the evening of September 7, 1904, at the society's house, 220 West Fifty-seventh street, New York City. Two papers were read: "The Installation of a Pneumatic Pumping Plant," by Mr. A. H. Diamant, and "Some Notes on the Creeping of Rails," by Mr. S. T. Wagner. The first paper described the work of putting in a Harris air-displacement pumping plant at the east end of the Croton Aqueduct tunnel under the Harlem River, at New York City. The plant is intended to clear the tunnel and its shafts of water whenever necessary for inspection, etc.; it had to be installed in a shaft filled with water, about 330 feet deep. The air tanks and

piping were erected in successive stages, beginning with the bottom, that is, the tanks, and lowering the whole into the shaft gradually as the successive sections of piping were added.

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In the presence of the Postmaster-General, a number of other Government officials and a crowd of about five hundred business men, a pneumatic mail tube service was formally opened in the temporary post office building on the lake front, in Chicago, on August 24. The system consists of double tubes and is 9 miles long, being the longest system in this country. The cost of installation was $650,000, and the routes are as follows: No. 1. From the new building to the temporary post office and to the Northwestern station. No. 2. From the new building to the La Salle street railroad station and thence to the Union station. No. 3. From the new building to the Illinois Central station, Twelfth street and Michigan boulevard; thence to the Twenty-second street postal station; thence to Armour station, and then to the stockyards. By this system of conduits 3,000 letters per minute can be carried each way. The first matter to be received through the tubes was a silk American flag. The first letter to pass through the tubes was addressed to President Roosevelt. The exercises were directed by Mr. Coyne, who, in an address, said: "While the tube system we are inaugurating to-day is designed principally for carrying letter mail, the great question as to how to handle the more bulky mail has brought under consideration the use of electric cars running through the underground system of the Illinois Tunnel Company. Congress has made an appropriation for a trial of this scheme, and, as it appears adequate, I have no doubt it will be adopted." W. E. L. Dillaway, of Boston, spoke in behalf of the tube company, saying that Chicago was the fifth city to get the pneumatic service.—*Railway and Engineering Review.*

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S. Pearson & Son, Incorporated, who are building the Pennsylvania Railroad tunnels under the East River and Long Island City, have just awarded the contract for two complete compressed air power plants, ready to operate, to The Ingersoll-Sergeant Drill Company, of New York. The combined capacity of the plants consists of 50,000 cubic feet of low pressure air per minute, and 12,000 cubic feet of high pressure air per minute.

It will be remembered that the same company recently received an order from the O'Rourke Engineering & Construction Company for the compressed air plants to be used in building the Pennsylvania tunnel under the Hudson River.

It includes the following: Eight 16-inch and 34-inch and 26½-inch x 42-inch semi-tangye frame Corliss air compressors; two 16-inch and 34-inch and 22¼-inch and 15½-inch x 42-inch semi-tangye frame Corliss air compressors; two 16-inch and 34-inch and 15½-inch x 42-inch semi-tangye frame Corliss air compressors; ten 57-inch iron body vertical aftercoolers; ten 54-inch x 12-foot vertical air receivers, and two 60-inch x 14-foot vertical air receivers.

The equipment for these two plants will consist of the following: Ten 500 H. P. Sterling boilers, two complete gravity oiling systems, two feed water controllers, four forced draft fans and engines, six duplex feed pumps, two 3,000 H. P. open feed water heaters, six surface condensers, six air and circulating pumps for condensers, two hot well pumps, six 3,000-gallon centrifugal circulating pumps with engines, six oil separators for separating oil from exhaust steam, two air intake conduits and stacks, all the steam piping and covering, all the exhaust piping and covering, steam separators, all the boiler feed piping, all the circulating water piping, all the guard rails, all the drip system piping.

This order covers two complete plants erected on foundations, and is the largest order ever secured in the history of the business.

These plants have been designed and will be erected by The Ingersoll-Sergeant Drill Company, under the personal supervision of Mr. J. H. Jowett, sales manager of the company.

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Considerable attention has been attracted by the installation of a central compressed air power transmission plant at the North Amherst (O.) quarry of the Cleveland Stone Company, made by the Ingersoll-Sergeant Drill Company. A remarkable saving, amounting to approximately $50,000 a year, was reported. Since that time the air lines have been extended to two smaller quarries in the neighborhood, where the air is now used to operate

a 125 H. P. Brown Corliss engine driving a six-gang sawmill, two large pumps and several smaller ones, five channeling machines, five rock drills, four hoisting stations and several blacksmith fires.

The engineers in charge record the following savings as a result of the additional installation:

| | |
|---|---|
| Coal formerly burned, 20 tons run of mine, at $2.50 | $50 00 |
| Two engineers day and night in mill, mill boss now looking after air engine | 4 80 |
| Man for wheeling coal | 1 35 |
| Three firemen taken off hoist boilers | 3 75 |
| Repair men taking care of boilers, etc. | 2 50 |
| Two channeling machines shut down, because of increased capacity with air, two runners at $2, four helpers at $1.50 | 10 00 |
| Two drill men taken off for same reason | 3 00 |
| Repairs on the two channelers and drills shut down | 1 00 |
| Total daily reduction in cost following the change to air | $76 40 |

While there is a small additional cost for coke used for reheating, it is offset by the saving made in repairs, oil and other supplies through the reduction in the number of drills and channelers used.

Against this plant must be charged its proportion of the cost of the power. A record made for thirty days shows the net daily charge for power, including interest, depreciation, fuel, etc., as $16.40, making a net gain per day at these two quarries of $60. Counting three hundred days to the working year, the saving would amount to $18,000, a dividend of almost 50 per cent. on the original investment.

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The following communication appeared in a recent issue of the *Engineering and Mining Journal:*

*The Editor:*

Sir—The letters and articles appearing in your columns in regard to explosions in compressors and receivers have been very interesting. Such an accident occurred at the plant of the Royal Gold Mining Company in Georgia during the time that I had charge. We were running on single shift, and the foreman claimed that he himself had blown out and drained the receiver early in the morning, but as he was a careless fellow, I have my doubts about this. He did not report that he had found a leak in the flange union of the main from the compressor to the receiver, and had packed it by driving an ordinary wooden shingle into the leak.

The compressor, a Rand C. six drill, and hoisting engine were both in the same room, and were run by the same engineer. At 11.30 A. M. he started to lower a cage containing men, and immediately after starting he noticed that the compressor began to race and the air gauge ran up from 60 pounds pressure to 150 pounds; he started to leave his engine in order to shut off the compressor, but remembering his strict injunctions about hoisting men, stepped back to his engine just in time to avoid being killed by the head of the receiver, which was blown through both sides of the engine room and down into the field, several hundred feet away, wrecking, on its way, all the compressor pipes.

The receiver, which was of the well-known horizontal type, measured 42 inches in diameter by 10 feet in length. It was placed in the open air near the collar of the shaft, and an unobstructed view of it was obtainable from the blacksmith shop. At this point the smith's notice was first attracted by the hissing of escaping air at the flange union already mentioned, and upon looking in that direction he saw smoke and sparks issuing from the joint, and then saw the receiver hopping along the ground away from the compressor. The receiver moved its full length away from the compressor before the head next to the compressor let go with a tremendous report, as already described. Had the explosion occurred half an hour later there would have been great loss of life; as it was no one was killed. Upon examining the receiver it appeared to be in excellent condition, the stay-bolts of the head showed no weakness, and it seemed marvelous that it was wrenched free.

My explanation at the time was that the receiver had been carelessly cleaned; that there was an accumulation of oil and dust, which under the heavy pressure had formed an explosive gas and the shingle had given the spark to touch it off. Nothing unusual was noticed at the drills before they stopped, and the foreman claims that the safety valve on the receiver was

in good condition. From all these facts I think there can be no doubt that a very powerful explosive gas was formed, and formed very quickly, as the whole thing was over in a few seconds, before the cage had dropped 50 feet, and before any intimation had reached the drills 250 feet from the receiver.

S. H. BROCKUNIER.

WHEELING, West Va., June 15, 1904.

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The agitation in behalf of a pneumatic tube system for London by the representatives of the Batcheller Pneumatic Tube Company has resulted in a general discussion of the subject. The London newspapers have devoted considerable space to the subject. A number of communications have appeared over the signature of Kenneth E. Stuart, M. E., one of the engineers interested in the project. One of these, which appeared in the London Standard in reply to another letter, contains some interesting facts concerning this system and its possibilities in London. In part it reads:

"The pneumatic tube idea is as old as the reed and dart of the ancients, it is true. Small tubes have been used for many years. In them the despatch and delivery of the carrier is not automatic, and at full speed its kinetic energy is less than 2 foot pounds. The Batcheller system is entirely automatic, and deals with a carrier the energy of which is 1870 foot pounds. The value and immense superiority of the Batcheller system is, indeed, in its elaboration and refinement. by virtue of which carriers may be despatched at intervals of three seconds by simply sliding them into a chute through a hole in the floor, delivered without human agency at the particular station for which the selective device upon it may have been set before despatching, and automatically discharged from the line without escape of air, collision between carriers in transit or with carriers despatched at intermediate stations, insertion of carriers before locking or unlocking after insertion being impossible, etc. Far from being unimportant, these details make the difference between success and failure, and are, therefore, vital. Anyone who knows how may construct a 12-inch pneumatic tube, but until the Batcheller patents expire none can compete with the Batcheller system in efficiency. The steamship "Great Eastern," built many years ago, was a failure, yet the "Baltic," though larger, is a success. Why? Because of practical details.

"In asserting that a 12-inch tube is too small for parcel or even postal purposes, and instancing despatch between the Post Office and Euston, Mr. Bennett falls into the very natural error that wrecked the original enterprise in London and threatened the American enterprise in its infancy. The value of pneumatic tube service is less in accelerated transit than in continuous transmission. If the velocity attained were no greater than that of a mail van, it would still save hours. 'Accumulation is the thief of time.' If one posts a letter at, say, Paddington, for the City, does it go at once? No; it must wait for thousands of others to accumulate before a trip by van can be made. Result: An average of three hours and six minutes is required for delivery of a letter in London. When the tube system is constructed, the stations will be so numerous that it will be almost as easy to post a letter at a tube station as at a pillar-box. It will go at once, and be delivered within half an hour, or, if sent express, in fifteen minutes.

"Of course, in the despatch of mails to railway stations for outgoing trains, it is only the supplementary or late fee letters that are expedited by rapid transit of any kind, not those that originally have plenty of time to catch the train by ordinary methods of transportation. When pneumatic tubes are used for the purpose, the mail is put in bags at the station as fast as it is collected, and never accumulates at the Post Office; consequently the last despatch may be deferred until a few minutes before the train leaves instead of perhaps an hour. In this way, at a single railway station in Philadelphia 30,000 letters are advanced to earlier trains daily. The principle of despatch by trainload at infrequent intervals, as distinguished from continuous transmission, no matter what the speed, is therefore fundamentally wrong, and not only defeats the object of rapid transit in local service, but enormously increases the cost in both local and railway station service. This is one of the lessons taught by experience. 'No accumulation' is the modern watchword of progress in transportation methods. The capacity of a single line of 12-inch tube is one large van load every five minutes. That of the proposed system 10,000 average van loads per day.

"It has been shown, by data collected

during four years on two continents, with special attention to the parcel post and shops of London, that a 12-inch tube is large enough to transmit 90 per cent. of the parcels. The remaining 10 per cent. would not justify a larger tube, but will be expedited by other means. The present undertaking is purely British, only American experience has been called into requisition. The first patent known to the writer for a system employing a carrier propelled through a closed conduit by its own electric motor was issued about 1886. If desired, exact date and name of inventor will be offered for publication, so soon as communication can be had with home office. The Batcheller system grew out of the Electro-Pneumatic Company, now defunct."

The present operations of the Batcheller interests is briefly outlined by the London *Telegraph* as follows:

"Parliament is to be asked next session to give authority for the inauguration of an American system of pneumatic mail tubes throughout London. The Batcheller Pneumatic Tube Company, of Philadelphia, has undertaken to give a practical demonstration of the ease and rapidity with which post office mails and parcels may be carried all over London. The company has acquired 'Ranelagh House,' on the Fulham side of Putney Bridge, and there it has laid down some 800 feet of tubing of a diameter sufficient to carry 8-inch carriers. This is the size of the carrier used in America, but a 12-inch carrier is proposed for the system which the Batcheller company contemplates, with the sanction of Parliament, laying down throughout London. These carriers will be forced through the tubes at the rate of 40 miles an hour by means of a constant current of compressed air."

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The strongest stock company organizations ever gathered together have been put under contract for the Proctor companies at the Fifth Avenue and One Hundred and Twenty-fifth Street Theatres for the coming season. With Edwin Arden and Isabelle Evesson at the head of the Fifth Avenue company, and William Ingersoll and Beatrice Morgan at the head of the One Hundred and Twenty-fifth Street company, supported in each instance by a strong cast of experienced players, it is possible to present a much higher grade of attractions than the average stock company is capable of producing.

# INDEX.

## U.S. PATENTS GRANTED AUG., 1904.

**Specially prepared for COMPRESSED AIR.**

766,213. PNEUMATIC-TUBE SYSTEM. George F. Atwood, Hoboken, N. J., assignor to Western Electric Company, Chicago, Ill., a Corporation of Illinois. Filed Nov. 28, 1902. Serial No. 132,979.

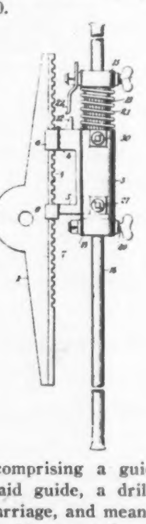
766,343. PNEUMATIC STACKER. Ezra L. Griffin, Mason City, Iowa. Filed Oct. 2, 1903. Serial No. 175,435.

766,405. PNEUMATIC RAILWAY-GATE. Frank E. Wilson, Lithopolis, Ohio, assignor of one-third to J. B. Kramer, Lancaster, Ohio. Filed Nov. 18, 1903. Serial No. 181,724.

The combination with gates, of cylinders arranged upon opposite sides of the gates, pistons movable in said cylinders, means for actuating said pistons, connecting means between the pistons and the gates, independent valve means adjacent the cylinders aforesaid, independent actuators disposed upon opposite sides of the gates, and connecting means between the said actuator and the remote valve means.

766,463. PNEUMATIC TIRE. Harry A. Palmer, Erie, Pa. Filed Feb. 15, 1904. Serial No. 193,669.

766,564. ROCK-DRILL. Frederick L. Whitehead, Butte, Mont. Filed July 14, 1903. Serial No. 165,420.

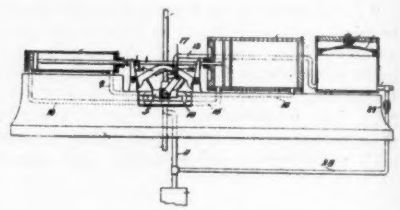


A rock-drill comprising a guide, a carriage movable along said guide, a drill-carrying tube movable in the carriage, and means for imparting rotary motion to said tube while moving back and forth, the said rotary motion being at all times in the same direction, and the said means causing the degree of rotary motion to increase with the increasing length of drill-strokes.

766,642. PRESSURE-RETAINING DEVICE FOR FLUID-PRESSURE BRAKES. Frederick Mertsheimer, Denver, Colo. Filed Jan. 2, 1904. Serial No. 187,517.

766,643. DIVING APPARATUS. Joseph von Miniszewski, Cologne, Germany, assignor to Graf Wlademir Skorzewski, Schloss Czerniejewo, near Schwarzenau, Germany. Filed Mar. 19, 1904. Serial No. 199,031.

766,876. MOTOR-DRIVEN EXHAUSTER AND COMPRESSOR. Melvin D. Compton, New York, N. Y. Filed Sept. 4, 1903. Serial No. 171,919.



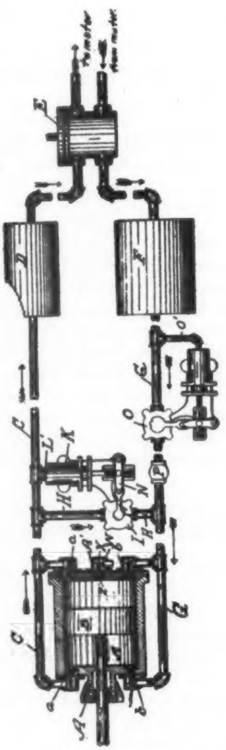
The combination of cylinders and their pistons and their motive-fluid connections, with valve devices for controlling the cylinder outlets and inlets for the fluid acted upon, and means operated by the pistons for instantly actuating and positively holding each and all of said valve devices, substantially as described.

766,915. AIR-BRAKE ACCELERATOR. Vernon C. Tasker, Washington, D. C., assignor to Societe Generale des Freins Lipkowski, Paris, France, a Firm. Filed Oct. 15, 1903. Serial No. 177,157.

767,098. AIR-VALVE. Charles H. Belden, Clifton Springs, N. Y., assignor to Judd and Leland Manufacturing Company, Clifton Springs, N. Y. Filed Nov. 18, 1903. Serial No. 181,679.

767,318. AIR-BRAKE TRIPLE VALVE. Vernon C. Tasker, Washington, D. C., assignor to Societe Generale des Freins Lipkowski, Paris, France, a Firm. Filed Oct. 15, 1903. Serial No. 177,158.

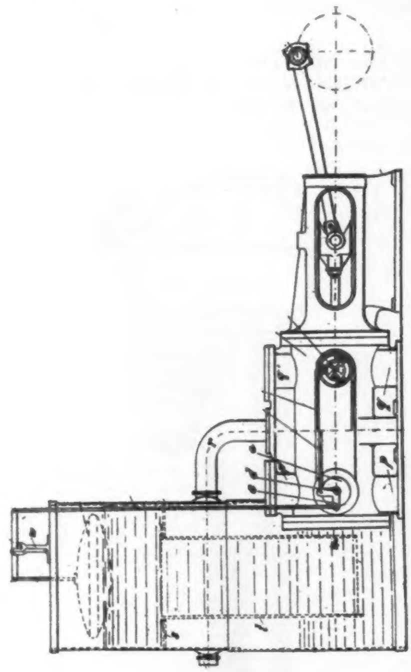
767,027. AIR COMPRESSION AND UTILIZING DEVICE. Melville C. Wilkinson, Los Angeles, Cal. Filed Dec. 13, 1900. Serial No. 39,778.



An air-compression system, the combination with a compression-cylinder provided with an induction and an eduction port at either end thereof, a high-pressure reservoir connected with the eduction-ports, a low-pressure reservoir connected with the induction-ports, a controller with which the reservoirs are connected, and a pipe extending between the connections of the reservoirs and cylinder, of a pressure-operated valve in the pipe, a check-valve in the connection leading from the low-pressure reservoir to the cylinder and a quick-acting valve located in said connection, pneumatic mechanism for operating the valve, the pneumatic mechanism, set to operate only when a predetermined pressure is reached.

767,296. PNEUMATIC SWEEPER. William P. Leister and Lafayette A. Hughes, Cliffside, N. C. Filed Mar. 24, 1904. Serial No. 199,829.

767,219. GAS-COMPRESSOR. Carl Flohr, Berlin, Germany. Filed Sept. 12, 1903. Serial No. 172,901.



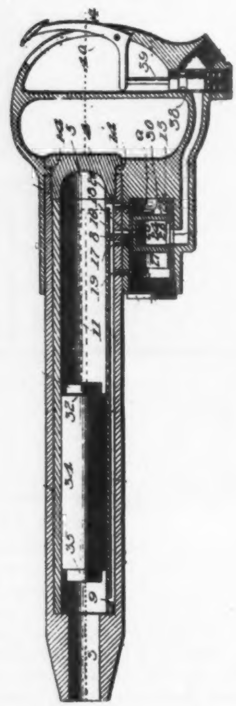
The combination with a double-acting gas-compressor comprising a cylinder with a channel connecting its two ends, of a rocking disk valve in said channel and adapted for opening and closing this channel, a compressed-gas-storage vessel partly filled with a fluid and divided by a partition-wall into two compartments one above the other and provided with a communicating tube reaching from the partition-wall down to a point above the bottom, a tube connecting the lower compartment of said compressed-gas-storage vessel with the delivery of said double-acting gas-compressor, a float in the upper compartment of said compressed-gas-storage vessel, and means for positively connecting said float with said rocking disk valve, so that the latter is more or less opened, when said float is moved.

767,278. ROCK-DRILL GUIDE. Hubert F. Huntington, Salmon, Idaho. Filed Sept. 17, 1903. Serial No. 173,542.

A rock-drill guide comprising a back frame, front plates, edge plates arranged between the

back frame and front plates and having diagonally-disposed slots, and clamping-bolts passing through said slots and through the back frame and front plates.

767,330. RECIPROCATING CYLINDRICAL VALVE. Arthur B. Denson, Beloit, Wis. Filed Apr. 22, 1902. Serial No. 104,176.



The combination with a piston cylinder provided with ports at its opposite ends, and a reciprocable piston therein, of a cylindrical valve-casing provided with ports communicating with the piston-cylinder, and a cylindrical valve in the casing consisting of a hollow cylinder having transverse partitions dividing the valve into a middle apartment having an inlet-port always open and an outlet-port leading into the piston-cylinder and open end cylindrical extensions to alternately open and close the ports leading from the valve-casing into the piston-cylinder, and means substantially as described to actuate the valve.

767,402. DEVICE FOR INFLATING PNEUMATIC TIRES. Frederick Glassup, New York, N. Y. Filed Oct. 2, 1903. Serial No. 175,412.

767,476. AIR-BRAKE. Weston M. Fulton, Knoxville, Tenn. Filed Mar. 18, 1903. Serial No. 148,338.

767,502. APPARATUS FOR EXHAUSTING VAPORS OR GASES. Vitus Schwaninger, Oggersheim, Germany. Filed Jan. 9, 1903. Serial No. 138,397.

An apparatus for exhausting gases or vapors, the combination of a vessel containing a sealing liquid, a chamber projecting downwardly into said vessel and communicating therewith and having an open bottom, means for connecting said chamber with an air-pump, a valve in said chamber opening into the atmosphere, means for connecting said vessel with a receptacle to be exhausted and a valve in said vessel opening into the atmosphere, substantially as and for the purpose set forth.

767,510. AIR-BRUSH. Olaus C. Wold, Chicago, Ill. Filed Mar. 14, 1904. Serial No. 197,951.

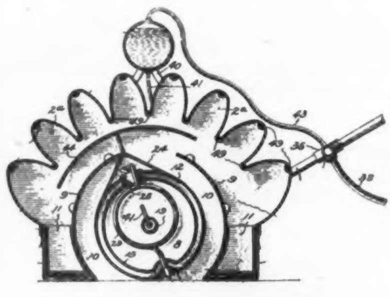
An air-brush, the combination of a needle rigidly mounted, a movable sleeve surrounding the needle and provided at its forward end with a discharge-opening, a casing surrounding the sleeve and provided with an air-passage therethrough, means for supplying air to the air-passage, and means for reciprocating the sleeve to enlarge or diminish the space around the needle, substantially as described.

767,597. LIQUID-FUEL DISTRIBUTER. James E. Raff, Montour, Iowa, assignor of one-half to Nathan W. Lundy, Marshalltown, Iowa. Filed Mar. 15, 1904. Serial No. 198,272.

An apparatus of the class described, the combination with a main fuel-tank, of an auxiliary fuel-tank serving also as a reservoir for compressed air, an air-pipe connecting said tanks, a fuel-conducting pipe leading from each tank to a common discharge-pipe, a filter mounted in said discharge-pipe, valves mounted in the fuel-conducting pipes for independently controlling the discharge of fuel from said tanks to the filter, and a pair of valves mounted in a common valve-casing, one for controlling the flow of air from the main to the auxiliary tank and the other for permitting the escape of air from the main tank when the opposite valve is closed.

767,611. PNEUMATIC COTTON-PICKER. James W. B. Turk, Poteau, Ind. Ter., assignor of one-half to William A. Welch, Jr., Poteau, Ind. Ter. Filed Jan. 29, 1904. Serial No. 191,215.

767,630. CARPET-RENOVATOR. Martin H. Collom, Denver, Colo., assignor of one-half to Nathaniel Maxcy Tabor, Denver, Colo. Filed Jan. 13, 1903. Serial No. 138,847.



A carpet-renovator comprising a casing open at the top and bottom, a cloth through which the air can escape, forming a cover over the top of said casing, dust-chambers within said casing, an air-nozzle adapted to discharge compressed air toward the bottom of said casing, and means in connection with said nozzle for heating the compressed air, substantially as described.

767,672. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Morris S. Wright, Worcester, Mass. Filed July 8, 1902. Serial No. 114,725.

767,705. ATTACHMENT FOR DENTAL ENGINES. Isidor Lyman, Cleveland, Ohio. Filed July 1, 1903. Serial No. 163,887.

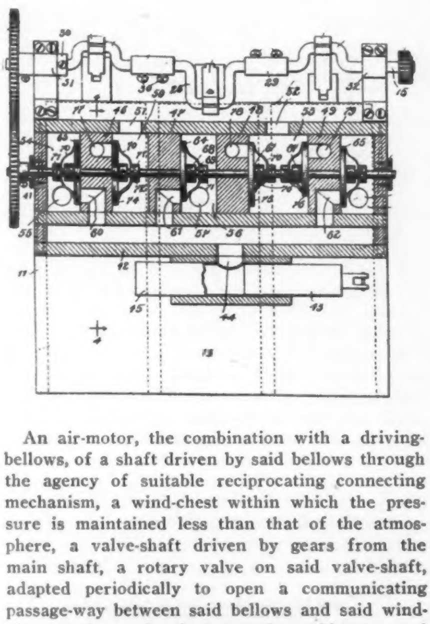
767,859. STRAINER ATTACHMENT FOR AUTOMATIC AIR-BRAKES. Samuel J. Ballance, August Uhlich and George Uhlich, Lincoln, Nebr. Filed Mar. 23, 1904. Serial No. 199,534.

767,968. SPRING AIR-GUN. Merritt F. Stanley, Northville, Mich., assignor to the James A. Dubnar Manufacturing Co., Northville, Mich. Filed Nov. 26, 1900. Renewed Jan. 2, 1904. Serial No. 187,521.

768,030. PNEUMATIC CARRIER. Charles H. Burton, Boston, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed Nov. 14, 1903. Serial No. 181,139.

768,031. PNEUMATIC-DESPATCH APPARATUS. Charles H. Burton, Boston, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed Nov. 14, 1903. Serial No. 181,140.

768,053. AIR-MOTOR. Axel F. Larson, Chicago, Ill. Filed July 13, 1903. Serial No. 165,349.



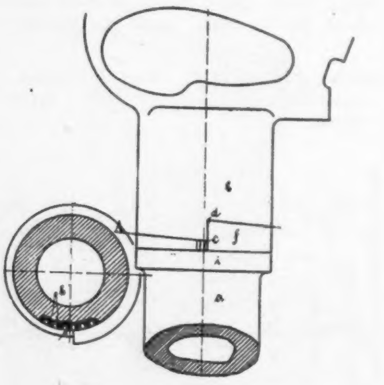
An air-motor, the combination with a driving-bellows, of a shaft driven by said bellows through the agency of suitable reciprocating connecting mechanism, a wind-chest within which the pressure is maintained less than that of the atmosphere, a valve-shaft driven by gears from the main shaft, a rotary valve on said valve-shaft, adapted periodically to open a communicating passage-way between said bellows and said wind-chest, and a spring-foot engaging said valve and tending to hold said valve lightly against its seat, the air-pressure serving to maintain said valve upon its seat.

768,145. PNEUMATIC HARNESS-SADDLE. John F. Plander, Dayton, Ohio. Filed May 2, 1904. Serial No. 205,914.

768,232. AIR-BRAKE PIPE-COUPLING. Thomas F. Lord, Mineral City, Ohio. Filed May 12, 1904. Serial No. 207,625.

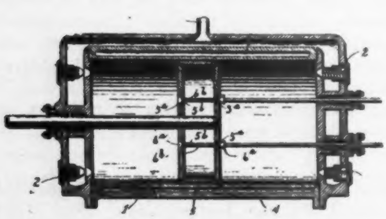
768,246. PRESSURE-REDUCING VALVE. John E. Taylor, Nashville, Mich. Filed Dec. 29, 1903. Serial No. 186,934.

768,294. LOCKING DEVICE FOR PNEUMATIC TOOLS. Carl F. W. A. Oetling, Strehla, Germany. Filed Aug. 22, 1903. Serial No. 170,411.



A device for locking the head to the cylinder of pneumatic tools, the combination, with the cylinder furnished at its end with grooves and the head formed with an abutment, of an elastic locking-ring cut at one point and having at one end a nose adapted to engage with one of the said grooves, and bearing by its face at the other end against the said abutment, substantially as and for the purpose herein set forth.

768,465. AIR-COMPRESSOR PISTON-VALVE. George J. Kennedy, Baltimore, Md. Filed Dec. 31, 1902. Serial No. 137,358.



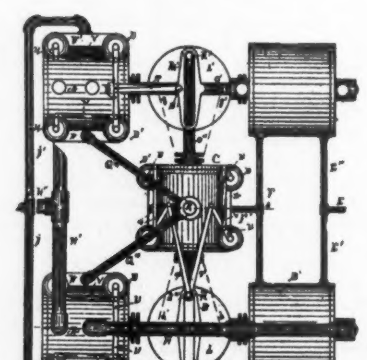
An air-compressor of that class employing a hollow or chambered piston and having a fixed piston-rod attached to said piston, a hollow air inlet or tube provided with oppositely-facing valves seating exteriorly in the heads of said piston and adapted to be actuated by said air-inlet tube, and said tube adapted to deliver air to the interior of said piston and into the piston-cylinder, the seats of said valves establishing communication between the interior of said piston and the interior of said cylinder.

768,278. PNEUMATIC TIRE. George H. Hastings, Oporto, Portugal. Filed Nov. 8, 1902. Serial No. 130,620.

768,371. RAILWAY AIR-BRAKE. Peter Jacobson, Milwaukee, Wis. Filed Jan. 16, 1904. Serial No. 189,310.

768,386. AUTOMATIC DIFFERENTIAL BRAKE-PRESSURE MECHANISM. Joseph Lord, Hays, Kans., assignor of one-half to Marquis L. Frizzell, St. Anthony, Idaho. Filed Dec. 23, 1903. Serial No. 186,392.

768,691. AIR-ENGINE. Wilson R. Pratt, Topeka, Kans. Filed Dec. 28, 1901. Serial No. 87,603.

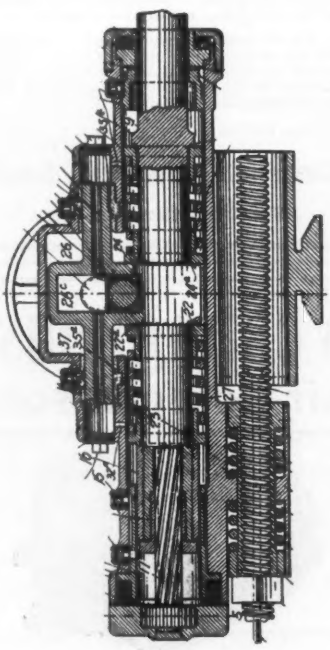


The combination of straight-line engines, jackets provided on said straight-line engines, air-compressors communicating with said jackets, said compressors delivering to said straight-line engines, jackets provided on said air-compressors, an oscillating primary engine adapted to exhaust into said straight-line engines, and receiving air from said last-named jackets, substantially as described.

768,462. PNEUMATIC SHEET-SEPARATOR. Charles A. Juengst, Croton Falls, N. Y. Original application filed July 18, 1900. Serial No. 24,017. Divided and this application filed Jan. 18, 1902. Serial No. 90,266.

768,495. GRIP-TREAD FOR PNEUMATIC TIRES. Harry D. Weed, Canastota, N. Y. Filed Feb. 9, 1904. Serial No. 192,803.

768,894. ROCK-DRILL. Henry Deitz, Denver, Colo., assignor to Lewis Deitz, Albany, N. Y. Filed Sept. 22, 1902. Renewed Jan. 30, 1904. Serial No. 191,392.



A drill, the combination of a casing having a central guideway and a longitudinal guideway located laterally of said central guideway, a drill-holder mounted to reciprocate in said central guideway, a tool-actuating part located laterally with relation to the drill-holder and bifurcated to straddle the latter, a projection extending from the tool-actuating yoke and fitting in the lateral longitudinal guideway to be limited thereby to a movement in a path parallel to that of the drill-holder, suitable bearings mounted on the drill-holder on opposite sides of the bifurcated yoke portion, and suitable means for reciprocating the yoke.

768,537. AIR-BRAKE. James F. McElroy, Albany, N. Y., assignor to Consolidated Car-Heating Company, Albany, N. Y., a Corporation of West Virginia. Filed Feb. 19, 1902. Serial No. 94,708.

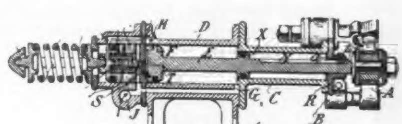
768,538. AIR-BRAKE. James F. McElroy, Albany, N. Y., assignor to Consolidated Car-Heating Company, Albany, N. Y. Filed Jan. 3, 1903. Serial No. 137,661.

768,639. AIR-BRAKE. Joshua F. Tipton, Baltimore, Md. Filed Jan. 7, 1904. Serial No. 188,069.

768,684. PNEUMATIC TIRE. John Parmley, Paterson, N. J. Filed Feb. 10, 1904. Serial No. 193,030.

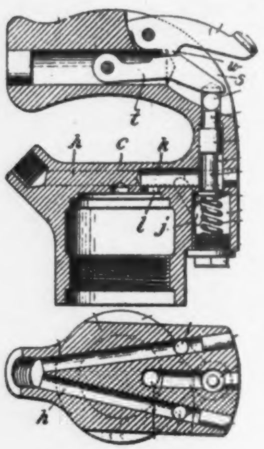
768,781. GRAIN-SAVING DEVICE FOR PNEUMATIC STACKERS. Eugene Thein, Clara City, Minn. Filed Jan. 11, 1904. Serial No. 188,459.

768,939. AUTOMATIC GOVERNOR FOR AIR-COMPRESSORS OR SIMILAR DEVICES. Milan W. Hall, New York, N. Y., assignor, by mesne assignments, to Noiseless Compressor and Air Brake Company, New York, N. Y., a Corporation of New York. Filed Apr. 2, 1903. Serial No. 150,745.




An automatic governor for air-compressors and similar devices, the combination of a switch, a cylinder and piston for operating said switch and connected to a source of fluid-pressure, a tubular extension C of said cylinder, a piston X traveling in said extension, a head on said extension having a port *a*, the rod of said piston having a groove Y therein registering with the port *a* and terminating short of the piston X whereby an air-cushion is formed in said extension near the end of the stroke.

768,898. THROTTLE-VALVE MECHANISM FOR PNEUMATIC HAMMERS. Charles H. Haeseler, Philadelphia, Pa., assignor to The Haeseler-Ingersoll Pneumatic Tool Company, New York, N. Y., a Corporation of West Virginia. Filed Mar. 11, 1904. Serial No. 197,628.



A pneumatic hammer, the combination with the head-block and the handle, of a valve-chamber at one side of said head-block, an ingress-passage extending to said valve-chamber through said head-block from the other side thereof, an egress-passage extending within said head-block from said valve-chamber to the interior of the head-block, a valve in said valve-chamber and an operating-lever connected with said valve.

769,036. VALVE MECHANISM. Herman Walther, Washington, Iowa. Filed Sept. 11, 1902. Serial No. 122,998.

An air-pump of the class described, the combination of a pumping-bell mounted in a tub, a motor-barrel provided with water connection, a piston mounted in said motor-barrel and connected to said bell, a valve mounted to regulate the flow of water into and out of said motor-barrel, a float arranged to be operated by the said bell, and means controlled by said float to operate said valve, substantially as described.

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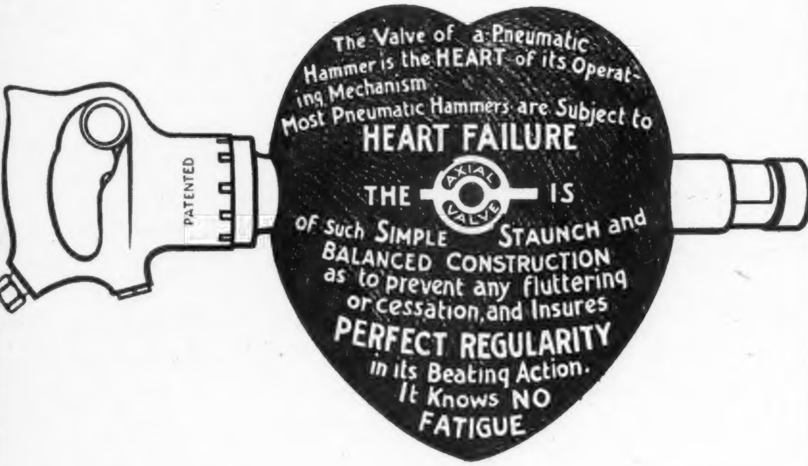


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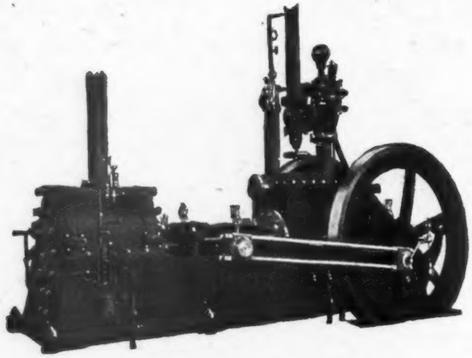

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